About the Consultant

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Dear Science Teacher,

As you begin a new school year, one of the biggest challenges you will probably encounter is getting students to read their textbooks. Informational text can overwhelm students, leaving them less likely to read and more likely to become apathetic about learning. I believe that this Science Notebook will help students use their textbooks more effectively as they learn about Chemistry.

Note-Taking and Student Success

There is considerable research evidence that addresses how students understand difficult concepts and content in school. Glencoe/McGraw-Hill has developed the Science Notebook for science students based upon that research. Evidence indicates that students need to know how to take notes, use graphic organizers, learn vocabulary, and develop their thinking skills by writing in order to achieve academic success.

The ability to take and organize notes predicts how well students will do in school. Peverly, Brobst, Graham, and Shaw (2003) showed that when students use background knowledge and take notes, they are likely to perform well on tests. Pauk (1974) observed that note-taking was a critical skill for college success. Notes serve as an external storage function (meaning on the paper) that builds comprehension and content understanding (Ganske, 1981). This Science Notebook is a tool that students can use to achieve this goal. I would like to share some of the features of this Science Notebook with you before you begin teaching.

The Cornell Note-Taking System

First, you will notice that the pages in the Science Notebook are arranged in two columns, which will help students organize their thinking. This two-column design is based on the Cornell Note-Taking System, developed at Cornell University. Faber, Morris, and Lieberman (2000) found that the Cornell Note-Taking System improves comprehension and increases test scores.

The column on the left side of the page highlights the main ideas and vocabulary of the lesson. This column will help students find information and locate the references in their textbooks quickly. Students can also use this column to sketch drawings that help them visually remember the lesson's information. In the column on the right side of the page, students will write detailed notes about the main ideas and vocabulary. The notes they take in this column will help them focus on the important information in the lesson. As students become more comfortable using the Cornell Note-Taking System, they will see that it is an important tool that helps them organize information.

The Importance of Graphic Organizers

Second, there are many graphic organizers in this Science Notebook. Graphic organizers allow students to see the lesson's important information in a visual format. In addition, graphic organizers help students summarize information and remember the content. I hope that you will encourage students to use the graphic organizers because they will help them understand what they are reading.
Research-Based Vocabulary Development

Third, you will notice that vocabulary is introduced and practiced throughout the *Science Notebook*. When students know the meaning of the words used to discuss information, they are able to understand that information better. Also, students are more likely to be successful in school when they have vocabulary knowledge. When researchers study successful students, they find that as students acquire vocabulary knowledge, their ability to learn improves (Martino and Hoffman, 2002). The *Science Notebook* focuses on learning words that are very specific to understanding the content of the textbook. The *Science Notebook* also highlights general academic words that students need to know so that they can understand any textbook. These vocabulary words are based on the Academic Word List (AWL) developed by Averil Coxhead. The AWL includes the most common 570 words found in academic texts, excluding the 2,000 general English words such as *the*, *in*, and *that*. Research indicates that students who master the words on Coxhead’s list score significantly higher on standardized tests.

Writing Prompts and Note-Taking

Finally, there are a number of writing exercises included in this *Science Notebook*. Writing is a useful tool that helps students understand the information that is being presented. Writing helps them to assess what they have learned. You will see that many of the writing exercises require students to practice the skills of good readers. Good readers *make connections* between their lives and the text and *predict* what will happen next in the reading. They *question* the information and the author of the text, *clarify* information and ideas, and *visualize* what the text is saying. Good readers also *summarize* the information that is presented and *make inferences* or *draw conclusions* about the facts and ideas.

I wish you well as you begin another school year. This *Science Notebook* is designed to help students understand the information in your Chemistry class. The guide will be a valuable tool that will also provide students with skills that they can use throughout their lives.

I hope you have a successful school year.

Sincerely,

Douglas Fisher

References


Your notes are a reminder of what you learned in class. Taking good notes can help you succeed in science. The following tips will help you take better classroom notes.

- Before class, ask what your teacher will be discussing in class. Review mentally what you already know about the concept.
- Be an active listener. Focus on what your teacher is saying. Listen for important concepts. Pay attention to words, examples, and/or diagrams you teacher emphasizes.
- Write your notes as clear and concise as possible. The following symbols and abbreviations may be helpful in your note-taking.

<table>
<thead>
<tr>
<th>Word or Phrase</th>
<th>Symbol or Abbreviation</th>
<th>Word or Phrase</th>
<th>Symbol or Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>for example</td>
<td>e.g.</td>
<td>and</td>
<td>+</td>
</tr>
<tr>
<td>that is</td>
<td>i.e.</td>
<td>approximately</td>
<td>≈</td>
</tr>
<tr>
<td>with</td>
<td>w/</td>
<td>therefore</td>
<td>:,</td>
</tr>
<tr>
<td>without</td>
<td>w/o</td>
<td>versus</td>
<td>vs</td>
</tr>
</tbody>
</table>

- Use a symbol such as a star (⭐) or an asterisk (*) to emphasize important concepts. Place a question mark (?) next to anything that you do not understand.
- Ask questions and participate in class discussion.
- Draw and label pictures or diagrams to help clarify a concept.
- When working out an example, write what you are doing to solve the problem next to each step. Be sure to use your own words.
- Review your notes as soon as possible after class. During this time, organize and summarize new concepts and clarify misunderstandings.

**Note-Taking Don’ts**

- **Don’t** write every word. Concentrate on the main ideas and concepts.
- **Don’t** use someone else’s notes as they may not make sense.
- **Don’t** doodle. It distracts you from listening actively.
- **Don’t** lose focus or you will become lost in your note-taking.
Before you read the chapter, write down four facts you know about chemistry.

1. 
2. 
3. 
4. 

Write three questions about scientific methods and research.

1. 
2. 
3. 
Introduction to Chemistry
Section 1.1 A Story of Two Substances

Scan Section 1 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 ozone and chlorofluorocarbons (CFCs).

Write four facts you discovered about ozone and chlorofluorocarbons (CFCs).
1. ____________________________________________
2. ____________________________________________
3. ____________________________________________
4. ____________________________________________

Use your text to define each term.
chemistry
__________________________

substance
__________________________
The Ozone Layer

Use with pages 5–7.

**Explain the ozone by completing the following paragraph.**

Overexposure to __________ causes sunburn, is harmful to __________, lowers __________, and disrupts __________. When __________ is exposed to ultraviolet radiation in the upper regions of the __________, a chemical called __________ is formed. About __________ of Earth’s ozone is spread out in a layer that surrounds and __________ our planet. Ozone forms over the __________ and flows toward the __________.

**Sequence the steps necessary for the formation of ozone.**

1. __________
2. __________
3. __________

**Illustrate the balance between oxygen gas and ozone levels in the stratosphere, using Figure 1.3 in your text as a model. Give it a title and label the parts of your model.**
Section 1.1 A Story of Two Substances (continued)

**Main Idea**

**Chlorofluorocarbons**

*Use with pages 7–8.*

**Details**

**Analyze** the graph in Figure 1.6. Write a brief description of the concentration of CFCs from 1977 through 1996.


**Analyze** chlorofluorocarbons by completing the following table.

<table>
<thead>
<tr>
<th>CFCs Were First Developed Because:</th>
<th>Facts about CFCs</th>
<th>Uses of CFCs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**REAL-WORLD CONNECTION**

Infer from your reading the potential connection between CFCs and the ozone layer. Use Figure 1.5 and the table in the Section 1.1 Assessment to draw your conclusions.


A Story of Two Substances
Introduction to Chemistry
Section 1.2 Chemistry and Matter

Main Idea

Details

**Skim** Section 2 of your text. Write four facts that come to mind from reading the headings, boldfaced words, and the illustration captions.

1. ____________________________________________
2. ____________________________________________
3. ____________________________________________
4. ____________________________________________

**New Vocabulary**

Use your text to define each term.

- **mass**
  ____________________________________________
- **weight**
  ____________________________________________
- **model**
  ____________________________________________
**Main Idea**

**Matter and its Characteristics**
*Use with pages 9–10.*

**Details**

**Compare and contrast** mass and weight using the Venn diagram below.
- does not reflect gravitational pull on matter
- a measure of the effect of gravitational pull on matter
- a measurement that reflects the amount of matter in an object

![Venn diagram showing mass and weight](image)

**Identify** six substances mentioned in the book that are important in everyday life and are made of chemicals.

1. 
2. 
3. 
4. 
5. 
6.
Organize the following terms by arranging them from largest to smallest.
macroscopic, submicroscopic, microscopic

Explain a chemical model by completing the following sentences.
The ________ composition, and ________ of all matter can be explained on a __________ level. All that we observe depends on ______ and the ______ they undergo. ______ seeks to explain the submicroscopic events that lead to __________________________.
One way to do this is by making a chemical model, a __________________________ of a ________________.

Real-World Connection
Analyze the importance of chemistry in our society using the branches of chemistry as examples.
Skim Section 2 of your text. Write three questions that come to mind from reading the headings, boldface terms, and illustration captions.

1. 
2. 
3. 

Use your text to define each term.

**scientific method**

**hypothesis**

**experiment**

**control**

**conclusion**

**theory**

**scientific law**

Compare the terms qualitative data and quantitative data.
**Main Idea**

**Details**

**Compare** the terms independent variable and dependent variable.

**Analyze** whether the characteristics listed below represent qualitative data, quantitative data, or both.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Type of Data</th>
</tr>
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<tbody>
<tr>
<td>the rate at which a candle burns</td>
<td></td>
</tr>
<tr>
<td>a blanket with varying degrees of softness</td>
<td></td>
</tr>
<tr>
<td>sand with a reddish-brown color</td>
<td></td>
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</tbody>
</table>

**Sequence** the steps of the scientific method.

1. Plan and set up one or more experiments to test one variable at a time.
2. Gather information using both qualitative data and quantitative data.
3. Observe, record, and analyze experimental data.
4. Develop a hypothesis, or tentative explanation based on observations.
5. Develop a theory or a scientific law.
6. Compare findings to the hypothesis, and form a conclusion.
Section 1.3 Scientific Methods (continued)

Main Idea

Use with page 15.

Details

Analyze Figure 1.13 and the caption information on Molina and Rowland’s model. Explain in words what the model visually predicts about the effect of ultraviolet radiation on CFCs.

SYNTHESIZE

Design a simple experiment using the scientific method. Give your experiment a descriptive title. Limit the number of variables you test. Write the steps of the experiment based on the scientific method, including but not limited to hypothesis, analysis, and conclusions. Draw a simple sketch of your experiment, if appropriate, and label the independent, dependent, and control variables.

Title: 

Steps: 

Independent variable(s): 

Dependent variable(s): 

Control variable(s): 

Next Page
Introduction to Chemistry
Section 1.4 Scientific Research

Main Idea

Details

**Skim** Section 4 of your text. Write three questions that come to mind from reading the headings, boldfaced terms, and illustration captions.

1. ____________________________________________________________________________
2. ____________________________________________________________________________
3. ____________________________________________________________________________

**New Vocabulary**

*pure research*

*applied research*

**Academic Vocabulary**

*recover*

*Use your text to define each term.*

*Define the following term.*
Describe scientific investigations by completing the following sentences.

Pure research becomes _______________ when scientists develop a hypothesis based on the data and try to solve a specific problem. _______________ have been made when a scientist reaches a conclusion far different than anticipated. Some wonderful scientific discoveries have been made _______________.

Review Table 1.2 in your text. Write an A if you agree with the statement. Write a D if you disagree with the statement.

___ Return unused chemicals to the stock bottle.
___ It is not safe to wear contact lenses in the lab.
___ Only a major accident, injury, incorrect procedure, or damage to equipment needs to be reported.
___ Graduated cylinders, burettes, or pipettes should be heated with a laboratory burner.

Analyze laboratory safety by responding to the following situations.

1. Explain in your own words why safety goggles and a laboratory apron must be worn whenever you are in the lab.

________________________________________________________________________

________________________________________________________________________

2. State why bare feet or sandals are not permitted in the lab.

________________________________________________________________________

________________________________________________________________________
3. Describe how you would explain to another student why you should not return unused chemicals to the stock bottle.

4. Explain why it is important to keep the balance area clean.

Some students are conducting an experiment that involves combining sodium and water. Too much sodium is added, which causes a fire. A student reacts by throwing water on the fire, but this only causes the fire to spread. The teacher finally puts the fire out. Based on what you now know about chemistry and lab safety, explain how this could have been avoided.
Chapter Wrap-Up

Now that you have read the chapter, review what you have learned. Fill in the blanks below with the correct word or phrase.

Chemistry is the study of ____________________________.
Matter is anything that has _____ and takes up ______. Mass is ____________________________ and differs from weight in that it does not measure the effect of _____________ on matter.
The steps of the scientific process include:


Two types of scientific investigation are:


Review

Use this checklist to help you study.

☐ Study your Science Notebook for this chapter.
☐ Study the vocabulary words and scientific definitions.
☐ Review daily homework assignments.
☐ Reread the chapter and review 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

Explain three ways you use chemistry in daily life.

1. ____________________________
2. ____________________________
3. ____________________________
Analyzing Data

Before You Read

Define the following terms.

qualitative data

quantitative data

variable

analysis

Chapter 1

You and a friend are making sweetened iced tea. You both have different opinions about how much sugar to add and at what temperature is best to add the sugar. Design an experiment to find out how much sugar will dissolve at three different temperatures. In your experiment, identify the following:

Qualitative data

Quantitative data

Independent variable

Dependent variable
Analyzing Data
Section 2.1 Units and Measurements

Main Idea

Skim Section 1 of your text. Write a question you have about each of the two types of units discussed in this section.

1. 

2. 

Details

New Vocabulary

Use your text to define each term.

base unit

derived unit

density

Match the SI base units below with their functions.

second → distance

meter → temperature

kilogram → time

kelvin → mass

liter → volume
Section 2.1 Units and Measurements (continued)

Main Idea

**Units**

*Use with page 32.*

**Identify** five items around your home that use SI units of measurement.

1. _____________________________________________

2. _____________________________________________

3. _____________________________________________

4. _____________________________________________

5. _____________________________________________

**Base Units and SI Prefixes**

*Use with pages 33–35.*

**Organize** these prefixes from smallest to largest.

___ pico  ___ giga
___ micro  ___ nano
___ deci    ___ milli
___ kilo    ___ centi
___ mega

**Temperature**

*Use with pages 34–35.*

**Compare and contrast** the kelvin scale and the Celsius scale.

________________________________________________________________________________

________________________________________________________________________________

________________________________________________________________________________

**Derived Units**

*Use with pages 35–37.*

**Explain** density by completing the following statement and equation.

Density is a _____ that __________ the _____ of an object to its ________.

density = ________
Using Density and Volume to Find Mass
Use with Example Problem 2.1, page 38.

Solve Read Example Problem 2.1 in your text.

You Try It

Problem
Determine the mass of an object that, when placed in a 25-mL graduated cylinder containing 14 mL of water, causes the level of the water to rise to 19 mL. The object has a density of 3.2 g/mL.

1. Analyze the Problem
   Known: 
   Unknown: 
   You know the density and the volume of an object and must determine its mass; therefore, you will calculate the answer using the density equation.

2. Solve for the Unknown
   Write the density equation.
   \[ \text{density} = \frac{\text{mass}}{\text{volume}} \]
   Rearrange the density equation to solve for mass.
   \[ \text{mass} = \text{density} \times \text{volume} \]
   Substitute the known values for _____ and ______ into the equation.
   \[ \text{mass} = 3.2 \text{ g/mL} \times 5.0 \text{ mL} = 16 \text{ g} \]
   Multiply the values and units. The mL units will cancel out.
   mass = _____ \times ______ = ___

3. Evaluate the Answer
   The two sides of the equation should be _____.
   density = ________________
   If you divide 16 g by 5.0 mL, you get _______.
Section 2.2 Scientific Notation and Dimensional Analysis

**Main Idea**

**Details**

Scan Section 2 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 this subject.

Write three facts you discovered about scientific notation and dimensional analysis.

1. 

2. 

3. 

New Vocabulary

Use your text to define each term.

**scientific notation**

**dimensional analysis**

**conversion factor**

Academic Vocabulary

Define the following term.

**sum**
**Main Idea**

**Scientific Notation**

*Use with Example Problem 2.2, page 41.*

**Details**

**Solve** Read Example Problem 2.2 in your text.

**You Try It**

- **Problem**
  
  Change the following data into scientific notation:
  
  a. The distance between Pluto and the Sun is 5,913,000 km.
  
  b. The density of nitrogen gas, a major component of Pluto's atmosphere, is .0012506 g/cm³.

1. **Analyze the Problem**
   
   Known: ____________________________
   
   Unknown: ____________________________
   
   You are given two measurements. In both cases, the answers will be factors between 1 and 10 that are multiplied by a power of ten.

2. **Solve for the Unknown**
   
   Move the decimal point to produce a factor between 1 and 10. Count the number of places the decimal point moved and the direction.

   \[
   \text{The decimal point moved} \quad \text{The decimal point moved}
   \]
   \[
   \_ \quad \text{places to the} \quad \_ \quad \text{places to the} \quad \_.
   \]
   
   Remove the extra zeros at the end or beginning of the factor.

   Multiply the result by \(10^n\) where \(n\) equals the _________
   
   _________. When the decimal point moves to the left, \(n\) is a ________ number. When the decimal point moves to the right, \(n\) is a ________ number. Remember to add units to the answers.

   a. ______________
   
   b. ______________

3. **Evaluate the Answer**
   
   The answers have ___ factors. The first factor is a number between _ and __. In answer a, because the distance to Pluto is a large number, 10 has a ______________. In answer b, because the density of nitrogen gas is a very small number, the exponent is ______.
Main Idea

Using Conversion Factors

Use with Example Problem 2.4, page 46.

Details

Solve Read Example Problem 2.4 in your text.

You Try It

Problem

The Cassini probe heading toward Saturn will reach speeds of 5.2 kilometers per second. How many meters per minute would it travel at this speed?

1. Analyze the Problem

Known: 

Unknown: 

You need conversion factors that relate kilometers to meters and seconds to minutes. A conversion factor is a _____ of _______ used to express _______ in _______.

2. Solve for the Unknown

First convert kilometers to meters. Set up the conversion factor so that the kilometer units will cancel out.

\[
\frac{5.2 \text{ km}}{\text{s}} \times \frac{1000 \text{ m}}{1 \text{ km}} = \frac{m}{\text{s}}
\]

Next convert seconds to minutes. Set up the conversion factor so that the seconds will cancel out.

\[
\frac{5200 \text{ m}}{\text{s}} \times \frac{60 \text{ s}}{1 \text{ min}} = \frac{m}{\text{min}}
\]

3. Evaluate the Answer

To check your answer, you can do the steps in reverse order.

\[
\frac{5.2 \text{ km}}{\text{s}} \times \frac{60 \text{ s}}{1 \text{ min}} = \frac{312 \text{ km}}{\text{min}} \times \frac{1000 \text{ m}}{\text{min}} = \frac{\text{km}}{\text{min}}
\]
Analyzing Data
Section 2.3 Uncertainty in Data

Main Idea

Skim Section 3 of your text. Focus on the headings, subheadings, boldfaced words, and main ideas. Summarize the main ideas of this section.

Details

New Vocabulary

Use your text to define each term.

- accuracy
- precision
- error
- percent error
- significant figure
Section 2.3 Uncertainty in Data (continued)

**Main Idea**

**Error and Percent Error**

*Use with pages 48–49.*

**Calculating Percent Error**

*Use with Example Problem 2.5, page 49.*

**Details**

**Explain** percent error by completing the statement and equation below.

Percent error is the ____ of an ____ to an _____________.

\[
\text{Percent error} = \frac{\text{accepted value} - \text{measured value}}{\text{accepted value}} \times 100
\]

**Solve** Read Example Problem 2.5 in your text.

**You Try It**

**Problem**

Calculate the percent errors. Report your answers to two places after the decimal point. The table below summarizes Student B’s data.

<table>
<thead>
<tr>
<th>Trial</th>
<th>Density (g/cm³)</th>
<th>Error (g/cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.4</td>
<td>-0.19</td>
</tr>
<tr>
<td>2</td>
<td>1.68</td>
<td>0.09</td>
</tr>
<tr>
<td>3</td>
<td>1.45</td>
<td>-0.14</td>
</tr>
</tbody>
</table>

1. **Analyze the Problem**

   Known: ____________________________________________________________________

   Unknown: __________________________________________________________________

   Use the accepted value for density and the errors to calculate percent error.

2. **Solve for the Unknown**

   Substitute each error into the percent error equation.

   \[
   \text{percent error} = \frac{\text{accepted value} - \text{measured value}}{\text{accepted value}} \times 100
   \]

   \[
   \text{percent error} = \frac{1.59 \text{ g/cm}^3}{1.59 \text{ g/cm}^3} \times 100 = \boxed{0}\%
   \]

   \[
   \text{percent error} = \frac{1.59 \text{ g/cm}^3}{1.59 \text{ g/cm}^3} \times 100 = \boxed{0}\%
   \]

   \[
   \text{percent error} = \frac{1.59 \text{ g/cm}^3}{1.59 \text{ g/cm}^3} \times 100 = \boxed{0}\%
   \]

3. **Evaluate the Answer**

   The percent error is greatest for trial ___ which had the largest error, and smallest for trial ___ which was closest to the accepted value.
Section 2.3 Uncertainty in Data (continued)

Identify the significant numbers below by drawing a circle around them. Use the five rules for recognizing significant digits on page 51 for reference.

0.0______ 00

Explain the rules for rounding numbers by completing the following sentences. Then complete the example of each rule for rounding numbers.

1. If the digit to the immediate right of the last significant figure is less than five, _________________________
   3.751 _____

2. If the digit to the immediate right of the last significant figure is greater than five, _________________________
   4.127 _____

3. If the digit to the immediate right of the last significant figure is equal to five and is followed by a nonzero digit, ________________
   ________________
   8.3253 _____

4. If the digit to the immediate right of the last significant figure is equal to five and is not followed by a nonzero digit, look at the last significant figure. ________________
   ______________________
   1.4750 = ___; 1.4650 = ___
Analyzing Data
Section 2.4 Representing Data

Scan Section 4 of your text. Use the checklist below as a guide.
• Read all section titles.
• Read all tables and graphs.
• Look at all pictures and read the captions.
• Think about what you already know about data analysis.

Write facts you learned about representing data as you scanned the section.
1. 
2. 
3. 

New Vocabulary
graph

Use your text to define the following term.

________________________________________
Section 2.4 Representing Data (continued)

Main Idea

Graphing

Use with pages 55–56.

Details

Draw and label (a) a circle graph and (b) a bar graph using the information in the table below.

<table>
<thead>
<tr>
<th>Student Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>Budget items</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>Car insurance</td>
</tr>
<tr>
<td>Movies</td>
</tr>
<tr>
<td>Books</td>
</tr>
<tr>
<td>Clothing</td>
</tr>
<tr>
<td>Miscellaneous</td>
</tr>
<tr>
<td>Gas</td>
</tr>
</tbody>
</table>

The ____________ best displays the data in the Student Budget table because __________________________________________
______________________________________________________________________.
Line Graphs

Use with pages 56–57.

Identify each of the following slopes.

______ slope

______ slope

Analyze whether the following sequences will likely plot as linear or nonlinear relationships.

Sequence A:  
Result 1: 2
Result 2: 4
Result 3: 7
Result 4: 10

Answer: _____

Sequence B:  
Result A: 31
Result B: 27
Result C: 49
Result D: 45

Answer: ______

Interpreting Graphs

Use with pages 57–58.

Organize information about interpreting graphs by completing the sentences below.

Information on a graph typically consists of _____ types of variables: ______ variables and ______ variables.

The relationship between the variables may reflect either a ______ or a ______ slope.

When reading the graph, you use either interpolation for ______

_________________________ or _____________ for estimated values beyond the plotted points.
Now that you have read the chapter, review what you have learned. Write out the key equations and relationships.

density =

percent error = \times 100

slope =

Conversion between temperature scales:

°C + ___ = __

K - ___ = __

Use this checklist to help you study.

☐ Study your Science Notebook for this chapter.

☐ Study the definitions of vocabulary words.

☐ Review daily homework assignments.

☐ Reread the chapter and review 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.

If you were a scientist, what precautionary guidelines would you use to ensure the accuracy of your data and to provide a clear representation of that data?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
Matter—Properties and Changes

Before You Read

<table>
<thead>
<tr>
<th><strong>Review Vocabulary</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Define the following terms.</strong></td>
</tr>
<tr>
<td><strong>matter</strong></td>
</tr>
<tr>
<td><strong>significant figure</strong></td>
</tr>
</tbody>
</table>

**Chapter 2**

Measure the height and arm length for five friends or family members. In the space below, create an appropriate graph to represent the data you collected.

Compare and contrast circle, bar and line graphs.
Matter—Properties and Changes
Section 3.1 Properties of Matter

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

1. 
2. 
3. 

Use your text to define each term.

states of matter
  vapor

physical property

extensive property

intensive property

chemical property

Match each of the following states of matter with its physical description.

solid flows and fills the entire volume of its container
liquid has definite shape and volume
gas flows and has a constant volume

Define the following term.

resource
Section 3.1 Properties of Matter (continued)

**Main Idea**

**Details**

**States of Matter**

*Use with pages 71–72.*

**Compare** the way the three common states of matter fill a container.

**REAL-WORLD CONNECTION**

Meteorologists (scientists who study weather) refer to water in the gaseous state in the atmosphere as water vapor. Explain why this term is used.
Section 3.1 Properties of Matter (continued)

Main Idea

Physical and Chemical Properties of Matter

Contrast intensive and extensive physical properties.

List several physical properties and explain why they are used more than chemical properties in the identification of objects.

Compare the properties of water at room temperature with water that has a temperature greater than 100°C.
Section 3.2 Changes in Matter

Scan Section 2 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 this subject.

Write three facts you discovered about changes in matter.

1. 

2. 

3. 

New Vocabulary

Use your text to define each term.

physical change

phase change

chemical change

law of conservation of mass
Section 3.2 Changes in Matter (continued)

Main Idea

Physical and Chemical Changes

Use with pages 76–77.

Details

Determine which type of change each statement represents. Use P for physical change and C for chemical change. Explain your answers.

silver spoon tarnishes ___
Explanation: _______________________________

crushing an aluminum can ___
Explanation: _______________________________

freezing water ___
Explanation: _______________________________

burning wood ___
Explanation: _______________________________

copper turns a greenish color ___
Explanation: _______________________________

grind coffee beans ___
Explanation: _______________________________

Describe how iron turns into a brownish-red powder. Name the reactants and product that are involved.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

34 Changes in Matter
Conservation of Mass

Use with Example Problem 3.1, page 78.

Summarize Fill in the blanks to help you take notes while you read Example Problem 3.1.

Problem
The total _____ of the products must ______ the total mass of the __________. This shows the law of ____________________.

1. Analyze the Problem
   Known:
   ____________________________________________________________
   ____________________________________________________________
   Unknown:
   ____________________________________________________________

2. Solve for the Unknown
   Write an equation showing conservation of mass of reactants and products.
   mass of ________ = mass of ______ + mass of ______
   Write an equation to solve for the mass of oxygen.
   mass of _____ = mass of ___________ − mass of ______
   Substitute known values and solve.
   Mass of oxygen = _____ g − _____ g
   Mass oxygen = _____ g

3. Evaluate the Answer
   Write an equation that shows mass of the two products equals the mass of the reactant.
   _____ g mercury + _____ g oxygen = _____ g mercury(II) oxide
Main Idea

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

• Read all section titles.
• Read all boldfaced words.
• Read all charts and graphs.
• Look at all pictures and read the captions.

List three facts you have learned about mixtures.

1. ____________________________________________
2. ____________________________________________
3. ____________________________________________

New Vocabulary

Use your text to find the correct term for each definition.

mixture

heterogeneous mixture

homogeneous mixture

solution

filtration

distillation

crystallization

sublimation

chromatography
Section 3.3 Mixtures of Matter (continued)

**Main Idea**

**Mixtures**

Use with pages 80–81.

**Details**

Describe how mixtures relate to substances.

Contrast heterogeneous and homogeneous mixtures.

Describe what an alloy is and why alloys are used.

Identify four techniques that take advantage of different physical properties in order to separate mixtures and describe how each is done.

Technique 1: ____________________
How it is done: ____________________

Technique 2: ____________________
How it is done: ____________________

Technique 3: ____________________
How it is done: ____________________

Technique 4: ____________________
How it is done: ____________________
Section 3.3 Mixtures of Matter (continued)

**Main Idea**

Technique 4: __________________
How it is done: ____________________________

**Details**

_Sequencing the steps of separating a mixture of sand, salt, and iron filings. Identify which physical property you were using in each step._

1. Mix the sand and salt mixture with water.
   - Physical property used: ____________________________

2. Boil the salt and water mixture, leaving the salt behind.
   - Physical property used: ____________________________

3. Separate the iron filings from the sand and salt by using a magnet.
   - Physical property used: ____________________________

4. Use filtration to separate the sand from the salt and water.
   - Physical property used: ____________________________

**Real-World Connection**

Crude oil (petroleum) is a mixture of several materials, including gasoline, kerosene, diesel fuel, and heating oil. Describe whether you think distillation or filtration would be a better method to separate the products of crude oil. Hint: each of the products listed has a different boiling point.
Scan Section 4 of your text. Review the periodic table of elements. Record some observations about how the table is organized and what information you can determine just by looking at the table.

New Vocabulary

Use your text to define each term.

**element**

**periodic table**

**compound**

**law of definite proportions**

**percent by mass**

**law of multiple proportions**
Elements and Compounds

Use with pages 84–87.

Discuss elements and compounds by completing the following paragraph.

There are ___ naturally occurring elements. Seventy-five percent of the universe is ________. The Earth’s crust and the human body are made of different elements. But ______ is an element that is abundant in both. Most objects are made of ________ with approximately ten million known and over ______ being developed and discovered every ____.

Analyze the concept map for matter in Figure 3.19. Write a brief description of the information the concept map is conveying.

Describe how the periodic table organizes elements.

Explain how Figure 3.18 illustrates the fact that the properties of a compound are different from the properties of its component elements.
Section 3.4 Elements and Compounds (continued)

Main Idea

Law of Definite Proportions
Use with pages 87–88.

Describe how to do percent by mass by completing the following paragraph.

The ______ of a compound is ______ to the ______ of the masses of the ______ that make up the compound. This demonstrates the law of ______________________.

Analyze the law of definite proportions by indicating whether the following examples are for identical or different compounds.

<table>
<thead>
<tr>
<th>Description</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compound 1 consists of 24g of Na, and 36g of Cl. Compound 2 has 36g of Na and 54g of Cl.</td>
<td></td>
</tr>
<tr>
<td>Compound 3 has 10.00g of lead and 1.55g of sulfur. Compound 4 has 10.00 g of lead, 1.55g of sulfur, and 1.55g of carbon.</td>
<td></td>
</tr>
</tbody>
</table>

Law of Multiple Proportions
Use with pages 89–90.

Describe the law of multiple proportions by completing the following statement.

When different ______ are formed by combining the same ______, different masses of one element combine with the same ______ of the other element in a ratio of ________________.

SYNTHESIZE

Carbon combines with oxygen to form two compounds, carbon monoxide and carbon dioxide. Based on the law of multiple proportions, describe how the proportions of oxygen in the two compounds relate to each other.
After reading this chapter, list three things you have learned about the properties and changes in matter.

1. 
2. 
3. 

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 and review 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

Explain how understanding the physical and chemical properties of matter can help find alternatives to the burning of fossil fuels, thus reducing the amount of harmful greenhouse gases released into the atmosphere.
The Structure of the Atom

Before You Read

Define the following terms.

- **scientific law**: 

- **theory**: 

- **element**: 

- **law of definite proportions**: 

- **law of multiple proportions**: 

Describe three things that you already know about the atom.

1. 

2. 

3. 

Describe three things that you already know about the atom.
The Structure of the Atom
Section 4.1 Early Ideas About Matter

Main Idea

Scan Section 1 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 this subject.

List three things you expect to learn about while reading the section.

1. ____________________________________________
2. ____________________________________________
3. ____________________________________________

New Vocabulary

Use your text to define each term.

Dalton’s atomic theory

________________________________________________

________________________________________________

________________________________________________
The Structure of the Atom

Section 4.1 Early Ideas About Matter (continued)

Main Idea | Details
--- | ---
**Greek Philosophers**

*Use with pages 102–103.*

**John Dalton**

*Use with page 104.*

**Summarize** the effect that Aristotle had on the atomic theory proposed by Democritus.

1. 

2. 

3. 

4. 

5. 

**List** the main points of Dalton’s atomic theory.

1. 

2. 

3. 

4. 

5. 

**Discuss** Dalton’s ideas by completing the following paragraph.

After years of studying ________________, Dalton was able to accurately determine the __________ of the elements involved in the reactions. His conclusions resulted in the ____________, which helped to explain that ________ in chemical reactions separate, __________, or ___________, but are not created, __________, or ___________.

The Structure of the Atom 45
**Main Idea**

**Details**

**Compare and contrast** the atomic theories of Democritus and Dalton. Mark an X under each name if a statement in the table applies to that person’s theory.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Democritus</th>
<th>Dalton</th>
</tr>
</thead>
<tbody>
<tr>
<td>All matter is made of tiny pieces.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Matter is made of empty space through which atoms move.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atoms cannot be divided.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atoms cannot be created.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atoms cannot be destroyed.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Different atoms combine in whole-number ratios to form compounds.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The properties of atoms vary based on shape, size, and movement.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Different kinds of atoms come in different sizes and shapes.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**REAL-WORLD CONNECTION**

The experiments of the alchemists revealed the properties of some metals and provided the foundation for the science of chemistry. Although not successful, alchemy proved beneficial to science. Explain how this example can be applied to modern research.
# The Structure of the Atom

## Section 4.2 Defining the Atom

**Main Idea**

Scan Section 2 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 this subject.

Write two facts you discovered about subatomic particles.

1. 
2. 

**Details**

Use your text to define each term.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>cathode ray</td>
<td></td>
</tr>
<tr>
<td>electron</td>
<td></td>
</tr>
<tr>
<td>nucleus</td>
<td></td>
</tr>
<tr>
<td>proton</td>
<td></td>
</tr>
<tr>
<td>neutron</td>
<td></td>
</tr>
</tbody>
</table>

Explain an atom by completing the following statements.

The atom is the _____________________________________________.

When a group of atoms ______________ and act as a __________, the result is known as a __________.
Section 4.2 Defining the Atom (continued)

**Main Idea**

The Electron

*Use with pages 107–110.*

**Details**

*Summarize the information you learned from cathode ray experiments. Use Figure 4.7 for reference.*

Cathode Ray Experiment

Altering the gas in the tube and the material used for the cathode have no effect.

Proves:

Cathode ray is deflected in a magnetic field.

Indicates:

Cathode ray is deflected toward the positively charged plate by an electric field.

Proves:

Identify the major discoveries about subatomic particles made by the 19th century.

1. _____________________________________________

2. _____________________________________________

3. _____________________________________________
The Structure of the Atom

Section 4.2 Defining the Atom (continued)

**Main Idea**

**The Nucleus**

*Use with pages 111–114.*

**Describe** Rutherford’s model of the atom by completing the following statements.

1. Most of an atom consists of ________ moving _________ through _________.

2. The electrons are ________ within the atom by their _________ to the positively charged _________.

3. The volume of ________ through which the electrons move is many times ________ than the volume of the _________.

**Organize** the properties of subatomic particles by completing the table below. Use Table 4.3 for reference.

<table>
<thead>
<tr>
<th>Electron</th>
<th>Proton</th>
<th>Neutron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symbol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td>in nucleus</td>
<td></td>
</tr>
<tr>
<td>Relative electrical charge</td>
<td>1+</td>
<td></td>
</tr>
</tbody>
</table>

**Summarize** what you have learned about subatomic particles by completing the following paragraph.

Atoms have a ________ shape. The ________ of an atom is made up of ________ that have a positive charge and ________ that have no _________. The nucleus makes up ________ of the mass of an atom. Most of an _________ is made up of negatively charged _________ traveling around the _________ charged nucleus. The _________ are held in place by their _________ to the positive charge of the _________. The ______ of the protons and neutrons are almost ________ to each other while the ______ of the electrons is _________.

The Structure of the Atom  49
The Structure of the Atom
Section 4.3 How Atoms Differ

Skim Section 3 of your text. Focus on the headings, boldfaced words, and main ideas. Then summarize the main ideas of this section.

1. 

2. 

3. 

New Vocabulary

In the left margin, write the term defined below.

the number of protons in an atom

atoms with the same number of protons but different numbers of neutrons

the sum of the number of protons and neutrons in the nucleus

1/12 the mass of a carbon-12 atom; the standard unit of measurement for the mass of atoms

the weighted average mass of the isotopes of an element

Academic Vocabulary

Define the following term.

specific
Section 4.3 How Atoms Differ (continued)

**Main Idea**

Atomic Number

*Use with page 115.*

**Details**

**Explain** how to use an atomic number to identify an element by completing the paragraph below.

Each _______ of an element has a unique number of _______.

Since the overall charge of an atom is _______ the number of _______ equals the number of _______. Atomic number = number of _______ = number of _______. If you know how many one of the three an atom contains, you also know the other _______. Once you know the ________________, the ____________ can be used to find the name of the _______.

**Solve** Read Example Problem 4.1 in your text.

**You Try It**

**Problem**

Given the following information about atoms, determine the name of each atom’s element and its atomic number.

- a. Atom 1 has 11 protons
- b. Atom 2 has 20 electrons

1. **Analyze the Problem**

Apply the relationship among atomic number, number of protons, and number of electrons to determine the name and atomic number of each element.

2. **Solve for the Unknown**

   a. **Atom 1**

   Atomic number = number of protons = number of electrons
   
   Atomic number = _____ = number of electrons
   
   The element with an atomic number of 11 is ____________.

   b. **Atom 2**

   Atomic number = number of protons = number of electrons
   
   Atomic number = number of protons = _____
   
   The element with an atomic number of _____ is ____________.

3. **Evaluate the Answer**

The answers agree with ____________ and element ____________ given in the periodic table.
Review your understanding of isotopes and mass number by completing the following paragraph.

Isotopes are elements with __________________________ but with __________________________. The number of neutrons can be determined by ____________ the atomic number from the ______________. The mass number is ____________________________

Solve Read Example Problem 4.2 in your text.

You Try It

Problem

You are given two samples of carbon. The first sample, carbon-12, has a mass number of 12, the second sample, carbon-13, has a mass number of 13. Both samples have an atomic number of 6. Determine the number of protons, electrons, and neutrons in each sample.

1. Analyze the Problem

Known:

<table>
<thead>
<tr>
<th>Carbon-12</th>
<th>Carbon-13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass number is ______</td>
<td>Mass number is ______</td>
</tr>
<tr>
<td>Atomic number is _____</td>
<td>Atomic number is _____</td>
</tr>
</tbody>
</table>

Unknown:

The number of protons, electrons, and neutrons in each sample.

2. Solve for the Unknown

Number of protons = number of electrons = atomic number = ___
Number of neutrons = mass number – atomic number
The number of neutrons for carbon-12 = 12 – 6 = ___
The number of neutrons for carbon-13 = 13 – 6 = ___

3. Evaluate the Answer

The number of neutrons does equal the ______________ minus the ______________, or the number of protons.
Section 4.3 How Atoms Differ (continued)

**Main Idea**

Mass of Atoms

*Use with pages 119–120.*

**Details**

Explain *why the mass number for chlorine is more than 35. Use Figure 4.17 for reference.*

Summarize *Fill in the blanks to help you take notes while you read Example Problem 4.3.*

**Problem**

Given the ______ in the table in the left margin, ______ the _________ of unknown element X. Then, ______ the unknown ______, which is used ______ to treat some _________.

1. **Analyze the problem**
   
   Known: Unknown:
   
   For isotope $^6X$: _________ of $X = ?$ amu
   
   mass = ________________ ____________ of element $X = ?$
   
   abundance = ________________
   
   For isotope $^7X$:
   
   mass = ________________
   
   abundance = ________________

2. **Solve for the unknown**
   
   Mass contribution = $(______)(______________________)$
   
   For $^6X$: Mass contribution = ________________ = ________
   
   For $^7X$: Mass contribution = ________________ = ________
   
   Sum the mass contributions to find the atomic mass.
   
   _________ of $X = __________________________ = ________
   
   Use the ________________ to identify the element.
   
   The element with an atomic mass of 6.939 amu is _________.

3. **Evaluate the answer**
   
   The number of neutrons does equal the __________ minus the ________________, or number of ____________.

---

**Isotope Abundance for Element X**

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Mass (amu)</th>
<th>Percent abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^6X$</td>
<td>6.015</td>
<td>7.59%</td>
</tr>
<tr>
<td>$^7X$</td>
<td>7.016</td>
<td>92.41%</td>
</tr>
</tbody>
</table>
## The Structure of the Atom
### Section 4.4 Unstable Nuclei and Radioactive Decay

**Main Idea**

*Skim Section 4 of your text. Write two questions that come to mind from reading the headings, and the captions.*

1. ____________________________________________
2. ____________________________________________

**New Vocabulary**

*Use your text to define each term.*

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>radioactivity</td>
<td></td>
</tr>
<tr>
<td>radiation</td>
<td></td>
</tr>
<tr>
<td>nuclear reaction</td>
<td></td>
</tr>
<tr>
<td>radioactive decay</td>
<td></td>
</tr>
<tr>
<td>alpha radiation</td>
<td></td>
</tr>
<tr>
<td>alpha particle</td>
<td></td>
</tr>
<tr>
<td>nuclear equation</td>
<td></td>
</tr>
<tr>
<td>beta radiation</td>
<td></td>
</tr>
<tr>
<td>beta particle</td>
<td></td>
</tr>
<tr>
<td>gamma ray</td>
<td></td>
</tr>
</tbody>
</table>
Section 4.4 Unstable Nuclei and Radioactive Decay (continued)

(Main Idea)

**Radioactivity**

*Use with pages 122–124.*

(Details)

**Explain** radioactivity by completing the paragraph below.

In chemical reactions, atoms may be ___________, but their ___________ do not change. The rearrangement ___________ only the ___________ of the atoms, not the ___________. ___________ are different. In nuclear reactions, ___________ gain stability by emitting ___________. As a result of ___________ in the nuclei, the atoms’ ___________ change. ___________ will continue emitting ___________, in a process called ___________, until stable nuclei, often of a ___________, are formed.

**Sequence** the steps of a nuclear reaction.

____ A stable, nonradioactive atom is formed.

____ Radiation is emitted.

____ The process of radioactive decay continues until the nucleus is stable.

____ An atom has an unstable nucleus.

**Distinguish** between alpha, beta, and gamma radiation by completing the table below.

<table>
<thead>
<tr>
<th>Radiation Type</th>
<th>Alpha</th>
<th>Beta</th>
<th>Gamma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symbol</td>
<td>$\frac{4}{2}$ He</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass (amu)</td>
<td>1/1840</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charge</td>
<td></td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

**Discuss** why some elements are radioactive while most elements are not.
The Structure of the Atom  Chapter Wrap-Up

Now that you have read the chapter, review what you have learned. List three important things you learned about the structure of an atom.

______________________________

______________________________

______________________________

Review

Use this checklist to help you study.

☐ Study your Science Notebook for this chapter.

☐ Study the definitions of vocabulary words.

☐ Review daily homework assignments.

☐ Reread the chapter and review 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

Radioactive materials are used in power plants and for medical uses. Some people object to the widespread use of nuclear reactors and radioactive materials. Discuss how what you’ve learned in this chapter affects your view on the use of radioactive materials.

______________________________

______________________________

______________________________

______________________________

______________________________

______________________________
Electrons in Atoms

Before You Read

**Chapter 4**

**Review** the structure of the atom by completing the following table.

<table>
<thead>
<tr>
<th>Part of the Atom</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>proton</td>
<td>centrally located part of the atom that contains protons and neutrons</td>
</tr>
<tr>
<td>electron</td>
<td>subatomic particle with no charge found in the ________</td>
</tr>
</tbody>
</table>

**Draw** a typical atom and label the structures.

**Identify** three facts about electrons.

Example: Electrons are a part of the structure of an atom.

1. 
2. 
3. 

Section 5.1 Light and Quantized Energy

Main Idea

Scan Section 1 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.

Write three facts you discovered about light.
1. 
2. 
3. 

New Vocabulary

Use your text to define each term.

electromagnetic radiation
wavelength

frequency

amplitude

electromagnetic spectrum
quantum

Planck’s constant

photoelectric effect

photon

atomic emission spectrum
The Atom and Unanswered Questions
Use with page 136.

Wave Nature of Light
Use with pages 137–140.

Main Idea

Details

List the three reasons scientists found Rutherford’s nuclear atomic model to be fundamentally incomplete.

1. 

2. 

3. 

Explain the relationship shown by the figure below. Use the following terms: wavelength, frequency, amplitude, and speed.

[Diagram of waves]
### Main Idea

**Calculating Wavelength of an EM Wave**

*Use with Example Problem 5.1, page 140.*

### Details

**Solve** Read Example Problem 5.1 in your text.

#### You Try It

**Problem**

Radio waves are used to transmit information on various channels. What is the wavelength of a radio wave having the frequency of $5.40 \times 10^{10}$ Hz?

1. **Analyze the Problem**
   - **Known:** $v$ and $c$
   - **Unknown:** $\lambda$
   
   You know that because radio waves are part of the electromagnetic spectrum, their speed, frequency, and wavelength are related by the formula $c = \lambda v$.

2. **Solve for the Unknown**

   Solve the equation relating the speed, frequency, and wavelength of an electromagnetic wave for wavelength ($\lambda$).

   If $c = \lambda v$, then $\lambda =$

   Substitute $c$ and the frequency of the radio wave, $v$, into the equation. Note that hertz is equivalent to $1/s$ or $s^{-1}$.

   $\lambda =$

   Divide the values to determine wavelength, $\lambda$, and cancel units as required.

   $\lambda =$

3. **Evaluate the Answer**

   The answer is correctly expressed in a unit of ____________ .

   Both of the known values in the problem are expressed with ____ significant figures, so the answer must have ____ significant figures.
Section 5.1 Light and Quantized Energy (continued)

**Main Idea**

**Particle Nature of Light**

*Use with pages 141–143.*

**Details**

**Identify two facts the wave model of light failed to explain.**

1. ________________

2. ________________

**Describe Planck’s quantum concept by completing the following statement.**

The quantum concept concludes that matter can gain or lose __________ only in small, specific amounts called ___________.

A quantum is the minimum amount of energy that can be __________ or __________ by an atom.

**Compare and contrast Einstein’s equation with Planck’s equation by completing the following sentence.**

Planck’s equation, __________, demonstrates mathematically that the energy of a quantum is related to the __________ of the emitted radiation. Einstein went further by explaining that, in addition to its wavelike characteristics, a beam of light can be thought of as a stream of __________ called __________.

**Contrast the continuous electromagnetic spectra and the atomic emission spectra.**

________________________

________________________

________________________

________________________

________________________
## Electrons in Atoms

### Section 5.2 Quantum Theory and the Atom

**Main Idea**

**Details**

*Skim Section 2 of your text. Write three questions that come to mind from reading the headings and the illustration captions.*

1. 
2. 
3. 

### New Vocabulary

**ground state**

**quantum number**

**de Broglie equation**

**Heisenberg uncertainty principle**

**quantum mechanical model of the atom**

**atom orbital**

**principal quantum number**

**principal energy level**

**energy sublevel**

*Use your text to define each term.*
Section 5.2 Quantum Theory and the Atom (continued)

**Main Idea**

Bohr Model of the Atom

*Use with pages 146–148.*

**Details**

Classify the characteristics of each series in hydrogen's line spectrum. Include the following information.

1. Beginning orbit(s)/ending orbit
2. Description of the spectral lines

<table>
<thead>
<tr>
<th></th>
<th>Balmer</th>
<th>Paschen</th>
<th>Lyman</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sequence de Broglie's process in developing his equation by completing the flow chart below.

Whole _________ of _________ are allowed in a circular orbit of fixed _________.

Light has both _________ and _________ characteristics.

Can particles of matter, including electrons, behave like _________?

If an electron has _________ and is restricted to circular orbits of fixed radius, the _________ is allowed only certain possible wavelengths, _________, and _________.

The Quantum Mechanical Model of the Atom

*Use with pages 149–150*
Section 5.2 Quantum Theory and the Atom (continued)

Main Idea

The Heisenberg Uncertainty Principle

Use with pages 151–152.

Discuss how Heisenberg’s principle influenced Schrödinger to develop his wave equation.

Hydrogen’s Atomic Orbitals

Use with page 153.

Identify four facts about atomic orbitals by completing the following statements.

1. ____________________________ indicate the relative sizes and energies of atomic orbitals.

2. The atom’s major energy levels are called ____________________________.

3. Principal energy levels contain ____________.

4. The number of ____________________________ in a principal energy level ______________ as \( n \) increases.

Summarize

Compare and contrast the Bohr and quantum mechanical models of the atom.
**Main Idea**

**Details**

**Skim** Section 3 of your text. Focus on the headings, subheadings, boldfaced words, and figure captions. Summarize the main ideas of this section.

<table>
<thead>
<tr>
<th>New Vocabulary</th>
</tr>
</thead>
<tbody>
<tr>
<td>electron configuration</td>
</tr>
<tr>
<td>aufbau principle</td>
</tr>
<tr>
<td>Pauli exclusion principle</td>
</tr>
<tr>
<td>Hund's rule</td>
</tr>
<tr>
<td>valence electron</td>
</tr>
<tr>
<td>electron-dot structure</td>
</tr>
</tbody>
</table>

Use your text to define each term.
Section 5.3 Electron Configurations (continued)

Organize information about electron configurations by completing the following outline.

Electron configuration is _____________________________.

I. Ground-state electron configurations
   A. Three rules define how electrons can be arranged in an atom’s orbitals:
      1. ____________________________
      2. ____________________________
      3. ____________________________
   B. The _________ methods for representing an atom’s electron configuration
      1. Orbital diagrams
         a. An empty box represents an _________________.
         b. A box containing a single up arrow represents an orbital with _________________.
         c. A box containing both up and down arrows represents a _________________.
         d. Each box is labeled with the _________________ and _____________ associated with the orbital.
      2. ____________________________
         a. This method designates the _________________ and _________________ associated with each of the atom’s orbitals, and includes a _________________.
            ____________________________
   C. Only valence electrons _____________________________.
      _____________________________.
      1. Electron-dot structures consist of the _________________, which represents the ____________________________ _________________, surrounded by dots representing the _____________________________.

Ground-State Electron Configurations
Use with page 156.

Orbital Diagrams and Electron Configuration Notation
Use with page 158.

Valence Electrons
Use with page 161.
Electron-Dot Structures
Use with Example Problem 5.3, page 162.

Solve Read Example Problem 5.3 in your text.

You Try It

Problem
Ruthenium (Ru) is commonly used in the manufacture of platinum alloys. What is the ground-state electron configuration for an atom of ruthenium?

1. Analyze the Problem

   Known: 
   Unknown: 

   Determine the number of additional electrons a ruthenium atom has compared to the nearest preceding noble gas, and then write out ruthenium’s electron configuration.

2. Solve for the Unknown

   From the periodic table, ruthenium’s atomic number is determined to be . Thus a ruthenium atom contains electrons. The noble gas preceding ruthenium is krypton (Kr), which has an atomic number of 36. Represent ruthenium’s first 36 electrons using the chemical symbol for krypton written inside brackets.

   The first 36 electrons have filled out the 1s, 2s, 2p, 3s, 3p, 4s, 3d and 4p sublevels. The remaining electrons of ruthenium’s configuration need to be written out. Thus, the remaining electrons fill the orbitals.

   Using the maximum number of electrons that can fill each orbital, write out the electron configuration.

3. Evaluate the Answer

   All electrons in a ruthenium atom have been accounted for. The correct preceding noble gas has been used in the notation, and the order of orbital filling for the is correct.
Electrons in Atoms  Chapter Wrap-Up

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

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

Review

Use this checklist to help you study.

☐ Study your Science Notebook for this chapter.

☐ Study the definitions for vocabulary words.

☐ Review daily homework assignments.

☐ Reread the chapter and review 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

Explain how advances in our understanding of the atom influence our daily lives.

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

68  Chapter Wrap-Up
The Periodic Table and Periodic Law

Before You Read

**Review Vocabulary**

Define the following terms.

- **atom**
- **electron configuration**
- **valence electrons**
- **electron-dot structure**

**Chapter 4**

Distinguish *between the subatomic particles in terms of relative charge.*

<table>
<thead>
<tr>
<th>Subatomic Particle</th>
<th>Electrical Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Describe *how the subatomic particles are arranged.*

________________________

________________________
The Periodic Table and Periodic Law
Section 6.1 Development of the Modern Periodic Table

Main Idea

**Skim** Section 1 of your text. Look at the headings, boldfaced words, figures and captions. Write two facts you discovered about the periodic table.

1. 
2. 

Details

**Use your text to define each term.**

- periodic law
- group
- period
- representative element
- transition element
- metal
- alkali metal
- alkaline earth metal
- transition metal
- inner transition metal
- nonmetal
- halogen
- noble gas
- metalloid
Section 6.1 Development of the Modern Periodic Table (continued)

**Main Idea**  
Development of the Periodic Table

Use with pages 174–176.

**Details**

Sequence the events that helped develop the periodic table.

1. In the 1790’s, ________________

2. In 1864, ________________

   and saw the properties of elements ________________

3. In 1869, ________________

   He left blank spaces ________________

4. In 1913, ________________

   He arranged elements by ________________

The Modern Periodic Table

Use with pages 177–180.

The Periodic Table of the Elements

<table>
<thead>
<tr>
<th>Period</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
<th>Group 5</th>
<th>Group 6</th>
<th>Group 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Li</td>
<td>Be</td>
<td>Mg</td>
<td>Na</td>
<td>K</td>
<td>Ca</td>
<td>Sc</td>
</tr>
<tr>
<td>2</td>
<td>Al</td>
<td>Si</td>
<td>P</td>
<td>S</td>
<td>Cl</td>
<td>Ar</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>K</td>
<td>Rb</td>
<td>Cs</td>
<td>Fr</td>
<td>Ba</td>
<td>La</td>
<td></td>
</tr>
</tbody>
</table>

**Determine** where you can find each of the following groups of elements on the periodic table below:

alkali metals nonmetals halogens

alkaline earth metals representative elements transition metals

inner transition metals transition elements noble gases

**Hint:** colored pencils might be helpful. Be sure to include a legend.
Section 6.1 Development of the Modern Periodic Table (continued)

**Main Idea**

Organize information about the periodic table by completing the concept map below.

The periodic table has ____ rows called periods.

The table has ____ columns called _______ or families

Groups

---

Groups 3–12 are called _______ which possess _______.

---

1 17 18

all metals alkaline halogens

except unreactive

more reactive than 2

---

divided into

inner transition metals transition metals earth metals

the and actinide series located at

---

Name ___________________________ Date _______________
Section 6.1 Development of the Modern Periodic Table (continued)

**Main Idea**

**Details**

Identify the information that is given on a typical box from the periodic table.

1. 
2. 
3. 
4. 
5. 

Match the box color on the periodic table in Figure 6.5 with the class of element the box describes.

blue nonmetal

green recently discovered

yellow metalloid

gray metal

---

**REAL-WORLD CONNECTION**

Describe how knowledge of the periodic table would be important in three different careers, based on what you’ve read.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
The Periodic Table and Periodic Law
Section 6.2 Classification of the Elements

Main Idea

Scan Section 2 of your text. Use the checklist below as a guide.
• Read all section titles.
• Read all boldfaced words.
• Read all tables.
• Look at all pictures and read the captions.
• Think about what you already know about the shapes and arrangements of atoms in covalent compounds.

Write three facts that you discovered about the relationship between electrons and an element’s location on the periodic table.

1. ____________________________

2. ____________________________

3. ____________________________

Vocabulary

Define the following terms.

structure
Organizing the Elements by Electron Configuration

Use with pages 182–183.

Organize information about electron configurations by completing the outline below.

I. Electrons
   A. Valence electrons
      1. electrons in ________________
      2. atoms in the __________ have ________________
      ________________.
   B. Valence electrons and period
      1. The __________ of an element's valence electrons indicates ________________.
         a. Elements with valence electrons in energy level 2 are found in ________________.
         b. Elements with ________________ are found in the fourth period.
   C. Valence electrons and group number
      1. Representative elements.
         a. All elements in group 1 have ________________.
         b. All elements in group 2 have ________________.
         c. Group 13 elements have ________________,
            group 14 elements have ________________, and so on.
      2. Helium, in group 18, is an ________________.

Describe the relationship between the number of valence electrons and the chemical properties of atoms.
Section 6.2 Classification of the Elements (continued)

Main Idea

The s-, p-, d-, and f-Block Elements

Use with pages 183–185.

Details

Distinguish between s-, p-, d-, and f-block elements by completing the table below.

<table>
<thead>
<tr>
<th>Periodic Table Groups</th>
<th>Orbitals</th>
<th>Type of Occupied Element</th>
</tr>
</thead>
<tbody>
<tr>
<td>s-block</td>
<td></td>
<td>representative elements</td>
</tr>
<tr>
<td>p-block</td>
<td>p</td>
<td></td>
</tr>
<tr>
<td>d-block</td>
<td>3 through 12</td>
<td></td>
</tr>
<tr>
<td>f-block</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Summarize Fill in the blanks to help you take notes while you read Example Problem 6.1.

Problem

Without using the periodic table, determine the group, period, and block in which strontium is located on the periodic table.

1. Analyze the problem
   Known: Unknown:
   Use the electron configuration of strontium to determine its place.

2. Solve for the unknown
   Group: Strontium has a valence configuration of ___. All group ___ elements have the ___ configuration.
   Period: The ___ in 5s^2 indicates that strontium is in _______.
   Block: The ___ indicates that strontium’s valence electrons _____________. Therefore, strontium is in the _______.

3. Evaluate the answer
   The relationships among ____________________ and ____________________ have been correctly applied.
The Periodic Table and Periodic Law

Section 6.3 Periodic Trends

**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.
- Look at all pictures and read the captions.

Write three facts that you discovered about periodic trends.

1. 

2. 

3. 

New Vocabulary

Use your text to define each term.

ion

ionization energy

octet rule

electronegativity
Section 6.3 Periodic Trends (continued)

Main Idea
Atomic Radius

Use with pages 187–188.

Details
Describe how atomic size is defined.

Analyze any trends that you observe in Figure 6.11 and how the trends relate to atomic mass.

Interpret Trends in Atomic Radii
Use with Example Problem 6.2, page 189.

Summarize Fill in the blanks to help you take notes while you read Example Problem 6.2.

Problem
Which has the largest atomic radius: carbon (C), fluorine (F), beryllium (Be), or lithium (Li)? Explain your answer in terms of trends in atomic radii.

1. Analyze the problem
   Known: periodic table information for four elements
   Unknown: which of the four has the

2. Solve for the unknown
   Use the _____________ to determine if the elements are in the same group or period. All four elements are in _____________.
   Order the elements from ____________ across the period.
   ________________
   Determine the largest based on trends of ________________.
   ________________

3. Evaluate the answer
   The ____________ in atomic radii have been correctly applied.
Section 6.3 Periodic Trends (continued)

**Main Idea**

**Ionic Radius**

*Use with pages 189–190.*

**Details**

Describe atomic size and ionic change by completing the table below.

<table>
<thead>
<tr>
<th>Ionic Change</th>
<th>Ion Charge</th>
<th>Size of Atom</th>
</tr>
</thead>
<tbody>
<tr>
<td>atom electrons</td>
<td>becomes positive</td>
<td></td>
</tr>
<tr>
<td>atom gains electrons</td>
<td>becomes</td>
<td>increases</td>
</tr>
</tbody>
</table>

Identify two reasons why the relative size of an atom becomes smaller due to the loss of electrons:

1. 
2. 

Explain why atoms increase in size when the atom gains electrons.

---

**Ionization Energy**

*Use with pages 191–193.*

Describe ionization energy trends on the periodic table by completing the paragraphs below.

Ionization energies generally ________ as you move left-to-right across a ______. Increased nuclear charge leads to an ________ on valance electrons. Ionization energy generally ________ when you move down a ______. Less energy is required to remove ________ because they are ______ from the nucleus.

The octet rule states that atoms tend to gain, lose, or share ________ in order to acquire a full set of ________.

First period elements are the ________ to this rule.

---

**Electronegativity**

*Use with page 194.*

Predict what part of the periodic table has the greatest electronegativity. Use Figure 6.18 for reference.
The Periodic Table and Periodic Law  Chapter Wrap-Up

Now that you have read the chapter, review what you have learned. List three facts about the periodic table and periodic law.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

Review

Use this check list to help you study.

☐ Study your Science Notebook for this chapter.

☐ Study the definitions and vocabulary words.

☐ Review daily homework assignments.

☐ Reread the chapter and review 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

Explain how an understanding of the periodic table can help you gain confidence in studying chemistry.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
Ionic Compounds and Metals

Before You Read

Define the following terms.

- **ion**
- **ionization energy**
- **noble gas**
- **valance electron**

Create electron-dot diagrams for the following elements.

- aluminum
- calcium:
- arsenic:
- tellurium:
- xenon:


Skim Section 1 of your text. Read the title and subheads. List three concepts that you think will be discussed in this section.

1. __________________________________________
2. __________________________________________
3. __________________________________________

Use your text to define each term.

- chemical bond
  __________________________________________
- cation
  __________________________________________
  __________________________________________
- anion
  __________________________________________
  __________________________________________
Section 7.1 Ion Formation (continued)

Valence Electrons and Chemical Bonds
Use with pages 206–209.

Main Idea

Organize information about forming chemical bonds by completing the concept map below.

As the number of ____________ in an atom increases, ____________, or the atom’s ability to attract electrons, _____________. Reactivity ____________.

Electron affinity is smallest for ____________, which in general have eight ____________ in their outermost s and p orbitals.

Details

Write the electron configuration of the most likely ion and the charge that is lost or gained by each of the following atoms. Indicate what the overall charge of the ion is, and whether it is a cation or an anion.

Cs: [Xe]6s\(^1\)

O: [He]2s\(^2\)2p\(^4\)

Ga: [Ar]4s\(^2\)3d\(^{10}\)4p\(^1\)

Br: [Ar]4s\(^2\)3d\(^{10}\)4p\(^5\)

Ag: [Kr]5s\(^1\)4d\(^{10}\)

Sc: [Ar]4s\(^2\)3d\(^1\)
**Main Idea**

Sequence the first group of elements in order of increasing ionization energy. Sequence the second group of elements in order of increasing electron affinity.

<table>
<thead>
<tr>
<th>First Group</th>
<th>Second Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>K → K⁺</td>
<td>P → P³⁻</td>
</tr>
<tr>
<td>Ne → Ne⁺</td>
<td>O → O²⁻</td>
</tr>
<tr>
<td>P → P⁵⁺</td>
<td>Xe → Xe⁻</td>
</tr>
<tr>
<td>Fe → Fe²⁺</td>
<td>S → S²⁻</td>
</tr>
<tr>
<td>Rb → Rb⁺</td>
<td>I → I⁻</td>
</tr>
<tr>
<td>Mg → Mg²⁺</td>
<td>F → F⁻</td>
</tr>
</tbody>
</table>

**Identify** the following ions.

<table>
<thead>
<tr>
<th>Ion</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ag⁺</td>
<td></td>
</tr>
<tr>
<td>Li⁺</td>
<td></td>
</tr>
<tr>
<td>Br⁻</td>
<td></td>
</tr>
<tr>
<td>Ca²⁺</td>
<td></td>
</tr>
<tr>
<td>S²⁻</td>
<td></td>
</tr>
<tr>
<td>B³⁺</td>
<td></td>
</tr>
<tr>
<td>As³⁻</td>
<td></td>
</tr>
<tr>
<td>H⁻</td>
<td></td>
</tr>
<tr>
<td>Cd²⁺</td>
<td></td>
</tr>
<tr>
<td>Se²⁻</td>
<td></td>
</tr>
</tbody>
</table>
Ionic Compounds and Metals
Section 7.2 Ionic Bonds and Ionic Compounds

Main Idea

Skim Section 2 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.

ionic bond

ionic compound

crystal lattice

electrolyte

lattice energy
Section 7.2 Ionic Bonds and Ionic Compounds (continued)

Main Idea

Formation of an Ionic Bond
Use with pages 210–212.

Details

Solve Read pages 211–213 in your text.

You Try It

Problem
Describe the formation of an ionic compound from the elements boron and selenium.

1. Analyze the Problem
Known: the electron configurations of the given elements
Unknown: the number of valence electrons for each neutral atom

2. Solve for the Unknown
Determine how many electrons need to be removed from boron and how many electrons need to be added to selenium to form noble gas configurations.

Determine how many boron atoms and how many selenium atoms must be present for the total number of electrons exchanged between the two elements to be equal.

3. Evaluate the Answer
The overall charge on one unit of this compound is zero.

boron ions (3+/boron ion) + selenide ions (selenide ion) = (3+) + ( ) = 0
Section 7.2 Ionic Bonds and Ionic Compounds (continued)

Main Idea

Properties of Ionic Compounds
Use with pages 212–217.

Details

Analyze the relationship between the lattice energy of an ionic compound and the force of attraction.

Describe the relationship between the size of the ions in a compound and the compound’s lattice energy.

Explain the relationship between lattice energy and the charge of the ion.

Organize the following ionic compounds from those with the least negative lattice energy to those with the most negative lattice energy.

_ _ LiCl
_ _ BeS
_ _ LiBr
_ _ BeO
_ _ BeCl₂
_ _ RbBr
_ _ CsI
_ _ SrCl₂
_ _ CsBr
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 diagrams.
- Look at all figures and read the captions.
- Study the example problems and note what they are intended to solve.
- Think about what you already know about the formation, formulas, and naming of ions and ionic compounds.

Write three facts that you discovered about the names and formulas of ionic compounds.

1. 
2. 
3. 

Use your text to define each term.

**New Vocabulary**

- **formula unit**
- **monatomic ion**
- **oxidation number**
- **polyatomic ion**
- **oxyanion**

**Academic Vocabulary**

Define the following term.

- **transfer**
Section 7.3 Names and Formulas for Ionic Compounds (continued)

### Main Idea

#### Formula for an Ionic Compound

*Use with Example Problem 7.1, page 220.*

#### Solve

Read Example Problem 7.1 in your text.

#### You Try It

**Problem**

Calcium can form a cation with a 2+ charge. Write the formula for the ionic compound formed from calcium ion and Chlorine.

1. **Analyze the Problem**
   - Known: the ionic forms of the component elements ____________ and ____________
   - Unknown: ____________

2. **Solve for the Unknown**
   - The smallest number that is divisible by both ionic charges is ____________, so the compound contains ____________ calcium ion(s) and ____________ sulfide ion(s). The formula for the ionic compound formed is ____________.

3. **Evaluate the Answer**
   - The overall charge on one formula unit of this compound is zero.
   - \[ \text{Ca ion(s)} (2+/ \text{Ca ion}) + \text{Cl ions} (1−/ \text{Cl ion}) = 0 \]

### Details

#### Formula for a Polyatomic Ionic Compound

*Use with Example Problem 7.3, page 222.*

#### Solve

Read Example Problem 7.3 in your text.

#### You Try It

**Problem**

Write the formula for the ionic compound formed from the calcium ion and the bromate ion.

1. **Analyze the Problem**
   - Known: the ionic forms of the component elements ____________ and ____________
   - Unknown: ____________
Section 7.3 Names and Formulas for Ionic Compounds (continued)

2. Solve for the Unknown

The smallest number that is divisible by both ionic charges is \( \text{____,} \) so \( \text{____} \) bromate ions combine with \( \text{____} \) calcium ion. The formula for the ionic compound formed is to form \( \text{____} \).

3. Evaluate the Answer

The overall charge on one formula unit of this compound is zero.

\[ 1 \text{ Ca ion (2+/Ca ion) } + \square \text{ BrO}_3 \text{ ions (1-/BrO}_3 \text{ ion) } = 0 \]

Classify the ions listed below as monatomic or polyatomic cations or anions. If the ion is a polyatomic anion, indicate whether it is an oxyanion.

\[
\begin{align*}
\text{CN}^- & \quad \text{______________} \\
\text{MnO}_4^- & \quad \text{______________} \\
\text{Ba}^{2+} & \quad \text{______________} \\
\text{Fe(CN)}_6^{4-} & \quad \text{______________} \\
\text{NH}_4^+ & \quad \text{______________} \\
\text{N}^3- & \quad \text{______________} \\
\text{Hg}_2^{2+} & \quad \text{______________} \\
\text{S}_2\text{O}_3^{2-} & \quad \text{______________} \\
\text{O}^2- & \quad \text{______________}
\end{align*}
\]

Identify the ionic compounds listed below.

\[
\begin{align*}
\text{CaO} & \quad \text{______________} \\
\text{KMnO}_4 & \quad \text{______________} \\
\text{Sr(IO}_3)_2 & \quad \text{______________} \\
\text{NH}_4\text{OH} & \quad \text{______________} \\
\text{Fe}_2\text{S}_3 & \quad \text{______________} \\
\text{Sn(NO}_3)_4 & \quad \text{______________} \\
\text{Pb}_3\text{(PO}_4)_2 & \quad \text{______________} \\
\text{Hg}_2\text{SO}_4 & \quad \text{______________} \\
\text{PtCl}_4 & \quad \text{______________}
\end{align*}
\]
Skim Section 4 of your text. Write three questions that come to mind from reading the headings and the illustration captions.

1. ______________________________________________________________________
2. ______________________________________________________________________
3. ______________________________________________________________________

Use your text to define each term.

electron sea model

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

delocalized electrons

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

metallic bond

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

alloy

________________________________________________________________________
Section 7.4 Metallic Bonds and the Properties of Metals (continued)

**Main Idea**

**Metallic Bonds**

*Use with pages 225–226.*

**Details**

**Summarize** *how the electron sea model accounts for the malleability, high thermal conductivity, and high electrical conductivity of metals.*

**Explain the properties of metals by completing the following sentences.**

The ____________ of transition metals increases as the number of delocalized electrons ___________.

Because the ___________ in metals are strongly attracted to the delocalized electrons in the metal, they are not easily ___________ from the metal, causing the metal to be very _____________.

Alkali metals are _______ than transition metals because they have only ________________ per atom.

The _______________ of metals vary greatly. The melting points are not as extreme as the _______________. It does not take an extreme amount of energy for _____________ to be able to move past each other. However, during ___________, atoms must be separated from a group of ________________, which requires a lot of _________.

Light absorbed and released by the ________________ in a metal accounts for the ______ of the metal.
## Section 7.4 Metallic Bonds and the Properties of Metals (continued)

### Main Idea

**Metal Alloys**

*Use with pages 227–228.*

### Details

Match the alloy composition given in the first column with the common name of the alloy in the second column and the alloy's uses in the third column. Draw lines between the appropriate items. Use Table 7.13 as a reference.

<table>
<thead>
<tr>
<th>Composition</th>
<th>Alloy</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>45% Cu, 15% Ag, 42% Au</td>
<td>cast iron</td>
<td>tableware, jewelry</td>
</tr>
<tr>
<td>75% Fe, 17% Cr, 8% Ni</td>
<td>10-carat gold</td>
<td>dental fillings</td>
</tr>
<tr>
<td>97% Fe, 3% C</td>
<td>sterling silver</td>
<td>casting</td>
</tr>
<tr>
<td>92.5% Ag, 7.5% Cu</td>
<td>dental amalgam</td>
<td>medals, bells</td>
</tr>
<tr>
<td>80% Cu, 15% Zn, 5% Sn</td>
<td>brass</td>
<td>instruments, sinks</td>
</tr>
<tr>
<td>85% Cu, 15% Zn</td>
<td>bronze</td>
<td>jewelry</td>
</tr>
<tr>
<td>50% Hg, 35% Ag, 15% Sn</td>
<td>stainless steel</td>
<td>hardware, lighting</td>
</tr>
</tbody>
</table>

**Contrast** a substitutional alloy with an interstitial alloy. Give an example of each.

<table>
<thead>
<tr>
<th>Substitutional Alloy</th>
<th>Example</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Interstitial Alloy</th>
<th>Example</th>
</tr>
</thead>
</table>

---

*Ionic Compounds and Metals* 93
# Ionic Compounds and Metals Chapter Wrap-Up

Now that you have read the chapter, review what you have learned. List three important facts about ionic compounds.

1. 
2. 
3. 

## Review

*Use this checklist to help you study.*

- Study your Science Notebook for this chapter.
- Study the definitions of vocabulary words.
- Review daily homework assignments.
- Reread the chapter, and review 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.

## Summarize

Explain how the atomic properties of an element determine what sort of ion it will form, and what properties a resulting ionic compound will have.

____________________
____________________
____________________
____________________
____________________
____________________
____________________
____________________

---

94  Chapter Wrap-Up
Covalent Bonding

Before You Read

**Review Vocabulary**

Define the following terms.

*ionic bond*

Describe the structure of an atom.

Chapter 4

Chapter 6

Explain the following concepts: periodic trends and periodic properties of elements.

Chapter 8

Identify the ions, along with their charges, in the following ionic compounds.

Li₂S

KMnO₄

Al₂O₃
Covalent Bonding
Section 8.1 The Covalent Bond

Main Idea

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

1. ____________________________
2. ____________________________
3. ____________________________

Details

Use your text to define each term.

covalent bond
molecule
Lewis structure
sigma bond
pi bond
endothermic reaction
exothermic reaction

New Vocabulary

Academic Vocabulary

Define the following term.

overlap
Section 8.1 The Covalent Bond (continued)

**Main Idea**

**Why do atoms bond?**
*Use with page 240.*

**What is a covalent bond?**
*Use with page 241.*

**Details**

**Explain** the octet rule by completing the following sentences.
The _____ rule states that ____________________________
_______________________________. Although exceptions exist, the rule provides a useful frame-
work for understanding ________________.

**Complete** the following sentences using words or phrases from your text.
The force between two atoms is the result of ________________
repulsion, nucleus-nucleus _________, and nucleus-electron
__________. At the point of ______________________, the _________
forces balance the _________ forces. The most stable arrangement
of atoms exists at the point of ________________, when the
atoms bond covalently and a _________ forms.

**Solve** Read Example Problem 8.1 in your text.

**You Try It**

**Problem**

Draw the Lewis structure for hydrochloric acid, HCl.

1. **Analyze the Problem**
   Write the electron-dot structures of each of the two component
   atoms.
   Known: H, \( \dot{\cdot} \)
   Unknown: _________________ of HCl
   Hydrogen, H, has only one valence electron. Chlorine, Cl, has
   seven valence electrons. Cl needs one electron to complete its
   octet.

2. **Solve for the Unknown**
   Draw the electron-dot structure for each of the component atoms.
   Then show the sharing of the pairs of electrons.
   
   \[
   \text{H} + \quad \text{Cl} \rightarrow \quad \text{H—Cl}:
   \]
   __________ __________ __________
   __________ __________ __________
Section 8.1 The Covalent Bond (continued)

Main Idea

Details

3. Evaluate the Answer
   Each atom in the molecule has achieved a __________ configuration and thus is ______.

Identify each bond between the component atoms as sigma bonds (single bonds), one sigma bond and one pi bond (double bonds), or one sigma bond and two pi bonds (triple bonds).

\[
\begin{align*}
   &H-C=C-H \\
   &H-C=O \\
   &\downarrow \\
   &H
\end{align*}
\]

Explain the factors that control the strength of covalent bonds.

Define bond dissociation energy.

Real-World Connection

Explain how understanding covalent bonding and the chemistry of compounds might help scientists increase food supplies.
The Covalent Bond
Section 8.2 Naming Molecules

Scan Section 2 of your text. Use the checklist below as a guide.
- Read all section titles.
- Read all boldfaced words.
- Read all tables and graphs.
- Read all formulas.
- Look at all figures and read the captions.
- Think about what you already know about the naming of molecules.

Write three facts you discovered about the names and formulas of covalent molecules.

1. 
2. 
3. 

Use your text to define the following term.

oxyacid
Section 8.2 Naming Molecules (continued)

Main Idea

Naming Binary Molecular Compounds

Use with Example Problem 8.2, page 249.

Details

Identify the prefixes for these three binary molecular compounds.

- Ge₃N₂: germanium nitride
- C₂Cl₄: carbon chloride
- B₆Si: boron silicide

Solve Read Example Problem 8.2 in your text.

You Try It

Problem

Name the compound N₂O₃.

1. Analyze the Problem

   Known: ____________________________
   Unknown: __________________________

   The formula reveals the elements present and the number of atoms for each element. Only two elements are present, and both are nonmetals, so the compound can be named according to the rules for binary molecular compounds.

2. Solve for the Unknown

   The first element present in the compound is __, _______. The second element is __, _______. The root of this name is __, so the second part of the name is _______. From the formula, two _______ atoms and three _______ atoms make up a molecule of the compound. The prefix for two is ___ and prefix for three is ___. The complete name for the compound is ____________________.

3. Evaluate the Answer

   The name ____________________ shows that a molecule of the compound contains _________ atoms and ___________ atoms, which agrees with the chemical formula for the compound, N₂O₃.
Section 8.2 Naming Molecules (continued)

**Main Idea**

**Naming Acids**
*Use with page 250.*

**Details**

**Match** the chemical formulas listed below with the correct acids.

- HF: sulfurous acid
- HIO₄: hydrofluoric acid
- H₂SO₃: phosphoric acid
- H₃PO₄: hypochlorous acid
- HC₂H₃O₂: periodic acid
- H₂CO₃: permanganic acid
- HClO: acetic acid
- HMnO₄: carbonic acid

**Writing Formulas from Names**
*Use with pages 251–252.*

**Write** the chemical formula for the molecular compound names given below. Use the flow chart in Figure 8.12 to help you determine the correct formulas.

- dicarbon tetrabromide
- tetrasulfur tetranitride
- arsenic pentafluoride
- arsenic acid
- perchloric acid
- hydrocyanic acid

**SYNTHESIZE**

Create questions and answers about naming molecules for your own original quiz game. Include topics such as: prefixes and number of atoms; formulas, common names, and molecular names for covalent binary compounds; and formulas, common names, and molecular names for binary acids and oxyacids.
Covalent Bonding
Section 8.3 Molecular Structures

Main Idea

Skim Section 3 of your text. Write three questions that come to mind from reading the headings, illustration captions, and topics for the example problems.

1. 

2. 

3. 

New Vocabulary

Use your text to define each term.

structural formula

resonance

coordinate covalent bond
Section 8.3 Molecular Structures (continued)

Main Idea

List the steps that should be used to determine Lewis structures.

1. 
2. 
3. 
4. 

Details

Structural Formulas

Use with pages 253–254.

Lewis Structure for a Covalent Compound with Multiple Bonds

Use with Example Problem 8.4, page 256.

Solve Read Example Problem 8.4 in your text.

You Try It

Problem

Draw the Lewis structure for FCHO.

1. Analyze the Problem

   Known: the compound formula: 
   Unknown: 

   Carbon has less attraction for shared electrons, so it is the central atom.

2. Solve for the Unknown

   Find the total number of valence electrons and the number of bonding pairs.

   \[ \text{valence electrons/C atom} + \text{valence electrons/F atom} + 1 \text{ valence electron/H atom} + \text{valence electrons/O atom} = \text{valence electrons} \]

   \[ \text{available valence electrons/(2 electrons/pair)} = \text{available pairs} \]
Section 8.3 Molecular Structures (continued)

Main Idea — Details

<table>
<thead>
<tr>
<th><strong>Main Idea</strong></th>
<th><strong>Details</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Draw single bonds, which represent _______________ each, from the carbon atom to each terminal atom, and place electron pairs around the ______ and ______ atoms to give them stable __________.</td>
<td></td>
</tr>
<tr>
<td>H—C—O:</td>
<td></td>
</tr>
<tr>
<td>:F:</td>
<td></td>
</tr>
<tr>
<td>______ available pairs – ______ pairs used = 0</td>
<td></td>
</tr>
<tr>
<td>Carbon does not have an octet, so one of the lone pairs on the ______ atom must be used to form a ______ bond.</td>
<td></td>
</tr>
</tbody>
</table>

3. Evaluate the Answer

Both carbon and ______ now have an octet, which satisfies the octet rule.

Solve Read Example Problem 8.5 in your text.

You Try It

Problem

**Problem**

Draw the Lewis structure for the permanganate ion ($\text{MnO}_4^-$).

1. Analyze the Problem

   **Known:** the compound formula: ______________
   **Unknown:** ______________

   Manganese has less attraction for shared electrons, so it is the central atom.

2. Solve for the Unknown

   Find the total number of valence electrons and the number of bonding pairs.

   $1 \text{ Mn atom} \times (\square \text{ valence electrons/Mn atom}) + \square \text{ O atoms} \times (6 \text{ valence electrons/O atom} + \square \text{ electron(s) from the negative charge}) = \square \text{ valence electrons}$
Section 8.3 Molecular Structures (continued)

Main Idea

- available valence electrons/(2 electrons/pair) = available pairs + 1 electron
  Draw single bonds, which represent an ____________, from the Mn atom to each O atom, and place electron pairs around the O atoms to give them stable _______.

     available pairs − pairs used = 0
     No electron pairs remain available for the Mn atom, so the Lewis structure for the permanganate ion is:

3. Evaluate the Answer

   All atoms now have an octet, and the group of atoms has a net charge of ____.

Explain resonance structures by completing the following sentences.

Each actual molecule or ion that undergoes ________ behaves as if it has only ____ structure. Experimentally measured bond lengths show that the bonds are ________ to each other.

List three reasons for exceptions to the octet rule.

1. ______________________________________________________________________

2. ______________________________________________________________________

3. ______________________________________________________________________

Resonance Structures

Use with page 258.

Exceptions to the Octet Rule

Use with pages 258–259.
Covalent Bonding
Section 8.4 Molecular Shapes

Main Idea

Scan Section 4 of your text. Use the checklist below as a guide.

- Read all section titles.
- Read all boldfaced words.
- Read all tables.
- Look at all pictures and read the captions.
- Think about what you already know about the shapes and arrangements of atoms in covalent compounds.

Write three facts you discovered about the shapes covalent compounds take.

1. 

2. 

3. 

New Vocabulary

Use your text to define each term.

**VSEPR model**

- 

- 

- 

- 

**hybridization**

- 

- 

- 

- 

Molecular Shapes
Section 8.4 Molecular Shapes (continued)

**Main Idea**

**VSEPR Model**
Use with pages 261–263.

**Details**

**Match** the molecular shapes listed below with their corresponding bond angles.

- trigonal planar: 180°
- trigonal pyramidal: 120°
- bent: 109.5°
- linear: 107.3°
- octahedral: 104.5°
- tetrahedral: 90° (out of plane); 120° (in plane)
- trigonal bipyramidal: 90°

**Hybridization**
Use with pages 262–263.

**Label** the hybrid orbitals in the figures below as sp, sp², sp³ sp³d, or sp³d₂.
Find the Shape of a Molecule
Use with Example Problem 8.7, page 264.

Solve Read Example Problem 8.7 in your text.

You Try It
• Problem — What is the shape of a SbI₅ molecule? Determine the bond angles, and identify the type of hybrid orbitals that form the molecule’s bonds.

1. Analyze the Problem
   Known: the compound formula: _____
   Unknown: ___________________________________________________________________

   The molecule contains one central antimony atom bonded to ____ iodine atoms.

2. Solve for the Unknown
   Find the number of valence electrons and the number of electron pairs.
   
   1 Sb atom \times (\underline{\text{valence electrons/Sb atom}}) + \underline{\text{I atoms}} \times (\underline{\text{valence electrons/I atom}}) = \underline{\text{valence electrons}}

   Three electron pairs exist on each iodine atom. This leaves \underline{\text{available valence electrons for bonding}}. \underline{\text{available valence electrons}}/(2 \text{electrons/pair}) = \underline{\text{available pairs}}

   Draw the molecule’s Lewis structure. From this Lewis structure, determine the molecular shape.

   Lewis structure  Molecular shape

   The molecule’s shape is ______________, with a bond angle of ____ in the horizontal plane, and a bond angle of ____ between the vertical and horizontal bonds. The bonds are made up of ______ hybrid orbitals.

3. Evaluate the Answer
   Each iodine atom has an octet. The antimony atom has ____ electrons, which is allowed when a d orbital is hybridized.
Covalent Bonding
Section 8.5 Electronegativity and Polarity

Main Idea

Details

Scan Section 5 of your text. Use the checklist below as a guide.

• Read all section titles.
• Read all boldfaced words.
• Read all tables and charts.
• Look at all pictures and read the captions.
• Think about what you already know about the strengths and distribution of charge in covalent bonds.

Write three facts you discovered about electronegativity.

1. 

2. 

3. 

New Vocabulary

polar covalent bond

Use your text to define the following term.

__________________________________________________________________________

__________________________________________________________________________
Sequence the following elements from the least electronegative to the most electronegative. Use Figure 8.20 for reference.

___ Au
___ Y
___ Ba
___ P
___ H
___ Te
___ O
___ I
___ Co

Draw the Lewis structure for each of the molecular compounds listed below. Analyze the symmetry of the structure to determine whether or not the compound is polar covalent or nonpolar covalent.

N₂

CO₂

CH₃Cl
Section 8.5 Electronegativity and Polarity (continued)

**Main Idea**

**Properties of Covalent Compounds**

*Use with pages 269–270.*

**Details**

Determine whether each of the properties listed below is characteristic of ionic compounds, covalent compounds, nonpolar covalent compounds, or polar covalent compounds.

- low melting point
- very soft solid
- high boiling point
- weak interaction between formula units
- solubility in oil
- very hard solid
- high melting point
- solubility in water
- easily vaporized
- strong interaction between formula units

Describe what the network solid for quartz \((\text{SiO}_2)\) molecules is like, and how it has a tetrahedral structure similar to diamond structure.
After reading this chapter, list three key facts about covalent bonding.

1. 
2. 
3. 

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 and review 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**

Explain how covalent bonds in carbon account for the vast number of carbon compounds, including those responsible for living organisms.
Chemical Reactions

Before You Read

**Review Vocabulary**

Define the following terms.

- ionic compound
- molecular compound

**Chapter 7**

Explain how to write formulas for ionic compounds.

Write the formula for the following ionic compound.

- aluminum carbonate

**Chapter 8**

Explain how to write formulas for molecular compounds.

Write the formula for the following molecular compound.

- sulfuric acid
Chemical Reactions
Section 9.1 Reactions and Equations

Main Idea

Scan Section 1 of your text. Use the checklist below as a guide.

• Read all section titles.
• Read all boldfaced words.
• Read all charts and graphs.
• Look at all pictures and read the captions.

Write three facts about chemical reactions.

1. ____________________________________________________________
2. ____________________________________________________________
3. ____________________________________________________________

New Vocabulary

In the left column, write the terms defined below.

a rearrangement of the atoms in one or more substances to form different substances

the starting substances of a chemical reaction

the substances formed during a chemical reaction

a statement that uses chemical formulas to show the identities and relative amounts of the substances involved in a chemical reaction

number written in front of a reactant or product that is used to balance chemical equations

Academic Vocabulary

Define the following term.

formula
Section 9.1 Reactions and Equations (continued)

Evidence of a Chemical Reaction

Use with page 282.

Identify three examples of chemical reactions you have seen, heard, or smelled in the last 24 hours. Think about activities at home, at school, or outside. Include any evidence you had that a chemical reaction was occurring.

<table>
<thead>
<tr>
<th>Reaction</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
</tr>
</tbody>
</table>

Representing Chemical Reactions

Use with pages 283–285.

Organize types of equations that can express a chemical reaction. In the second column, list the elements (words, coefficients, etc.) that are used to create each equation. In the third column, rank each equation from 1 to 3, giving a 3 to the equation that provides the most information, and a 1 to the equation that provides the least information.

<table>
<thead>
<tr>
<th>Type</th>
<th>Elements</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word equations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical equations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skeleton equations</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Label the chemical state each symbol below identifies in a chemical equation.

(s) ______________________

(g) ______________________

(aq) ______________________

(l) ______________________
Section 9.1 Reactions and Equations (continued)

You Try It

Problem
Balance the chemical equation for the reaction in which fluorine reacts with water to produce hydrofluoric acid and oxygen.

1. Analyze the problem
   Known: ________________
   Unknown: ________________

2. Solve for the Unknown
   Use the space below to write the skeleton equation:
   __________________________
   Count the atoms of each element in the reactants.
   _____ F, _____ H, _____ O
   Count the atoms of each element in the products.
   _____ F, _____ H, _____ O
   Insert the coefficient _____ in front of _____ to balance the oxygen atoms.
   Insert the coefficient _____ in front of _____ to balance the _____
   Insert the coefficient _____ in front of _____ to balance the _____
   Write the equation after adding the coefficients.
   __________________________
   Check that the coefficients are at their lowest possible ratio.
   The ratio of the coefficients is ______.
   Write the number of atoms in the balanced equation below:
   Reactants: __________________________
   Products: __________________________

3. Evaluate the Answer
   The ____________ of each element is _____ on both sides of the equation. The ____________ are written to the ______ ratio.
Chemical Reactions
Section 9.2 Classifying Chemical Reactions

Main Idea

Scan Section 2 of your text. Use the checklist below as a guide.

- Read all section titles.
- Read all boldfaced words.
- Read all charts and graphs.
- Look at all pictures and read the captions.
- Think about what you already know about chemical reactions.

Write three facts you discovered about classifying chemical reactions.

1. ____________________________________________

2. ____________________________________________

3. ____________________________________________

New Vocabulary

Use your text to define each term.

synthesis reaction

combustion reaction

decomposition reaction

single-replacement reaction

double-replacement reaction

precipitate
Section 9.2 Classifying Chemical Reactions (continued)

**Main Idea**

Complete the following diagrams illustrating each classification of chemical reaction. The first one has been completed for you.

**Synthesis Reactions**
*Use with page 289.*

Substance

Substance → New compound

A + B → _____

**Combustion Reactions**
*Use with pages 290–291.*

Metal, nonmetal, or compound substance

Compound

Element or

Element or

AB → _____

**Decomposition Reactions**
*Use with page 292.*

Compound

Element or

Element or

AB → _____

**Replacement Reactions**
*Use with pages 293–296.*

Compound

Metal or nonmetal

A + BX → _____

**Double-replacement reactions**

Compound with anion

AX + BY → _____
Section 9.2 Classifying Chemical Reactions (continued)

Use with pages 289–297.

Organize types of chemical reactions. The first column in the chart below lists some possible products in a chemical reaction. In the second column, write the type of chemical reaction that is likely to generate each product.

<table>
<thead>
<tr>
<th>Products</th>
<th>Possible Chemical Reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>two different compounds, one of which is often a solid, a gas, or water</td>
<td></td>
</tr>
<tr>
<td>oxide of the metal or a nonmetal or two or more oxides</td>
<td></td>
</tr>
<tr>
<td>two or more elements or compounds</td>
<td></td>
</tr>
<tr>
<td>a new compound and a replaced metal or nonmetal</td>
<td></td>
</tr>
<tr>
<td>one compound</td>
<td></td>
</tr>
</tbody>
</table>

ANALOGY

Consider the list of metals and halogens and their relative reactivity in Figure 9.13. Using your own experiences, identify people or things that could be ranked according to how they react in a certain situation.

1. (Example) Rank baseball bats by how likely they are to break.

2. ____________________________________________

3. ____________________________________________

4. ____________________________________________
Chemical Reactions
Section 9.3 Reactions in Aqueous Solutions

Main Idea

Consider the title and first paragraph in Section 3. Based on what you read, what do you expect to learn in this chapter?

Details

In the left column, write the terms defined below.

the most plentiful substance in a solution

substances dissolved in a solution

equations that include only particles that participate in a reaction

ion that does not participate in a reaction

ionic equation that shows all the particles in a solution as they realistically exist

a solution in which the most plentiful substance is water
Section 9.3 Reactions in Aqueous Solutions (continued)

Aqueous Solutions
Use with pages 299–300.

Types of Reactions in Aqueous Solutions
Use with pages 300–301.

Connect English words to their Latin roots. The term aqueous comes from the Latin word for water, aqua. Use a dictionary to find three words that also come from aqua, and list them in the box below together with a brief definition that explains their connection to water.

<table>
<thead>
<tr>
<th>Word</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Compare a complete ionic equation and a chemical equation.

Draw a circle around the spectator ions in the following equation.

\[2A^+(aq) + 2B^-(aq) + C^+(aq) + 2D^-(aq) \rightarrow 2A^+(aq) + 2D^-(aq) + 2BC\]

Identify whether each of the equations below is a complete ionic equation or a net ionic equation.

\[A^+(aq) + B^-(aq) + C^+(aq) + D^-(aq) \rightarrow AD + B^-(aq) + C^+(aq)\]

\[E^+(aq) + F^-(aq) \rightarrow EF\]

\[G^+(aq) + HI^-(aq) \rightarrow GI + H(g)\]
Reactions in Aqueous Solutions (continued)

Main Idea

Reactions That Form Water
Use with page 303.

Reactions That Form Water
Use with page 303.

Details

Compare reactions in aqueous solution that form a precipitate and reactions that form water. Put each of the following characteristics in the corresponding category.

- can be described with ionic equations
- generates a solid product
- double-replacement reaction
- has no observable evidence

Identify three commonly produced gases in reactions in aqueous solutions.

State the evidence that would indicate that carbon dioxide gas is escaping from the solution containing sodium hydrogen carbonate shown in Figure 9.19.

List the two reactions that occur when any acidic solution is mixed with sodium hydrogen carbonate.

122 Reactions in Aqueous Solutions
Sequence the steps in writing an overall equation.

1.
2.
3.
4.

What if ten years from now, you are a chemist working for a government agency that investigates chemical reactions. Read each of the case studies below, and in the space provided, list the type of chemical reaction that you think is involved and any products or effects that you would expect to discover during or after the chemical reaction.

1. Owners of an industrial plant plan to mix oxygen with existing chemical substances in order to create a new product.

<table>
<thead>
<tr>
<th>Type of Reaction</th>
<th>Product or Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Two vats of chemicals have spilled into a river and created a gelatinous ooze.

<table>
<thead>
<tr>
<th>Type of Reaction</th>
<th>Product or Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Chemical Reactions  Chapter Wrap-Up

Now that you have read the chapter, review what you have learned. List three facts you have learned about chemical reactions and the equations that describe them.

____________________________________
____________________________________
____________________________________

Review

Use this checklist to help you study.

☐ Study your Science Notebook for this chapter.

☐ Study the definitions of vocabulary words.

☐ Review daily homework assignments.

☐ Reread the chapter, and review the charts, 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.

SYNTHESIZE

Imagine you were asked to give an expert opinion on a magazine article before it is published. The article is on how to make your own household cleansers. You can tell that the author got the ingredients right, and she has amounts in the correct proportion. However, it looks to you like the author mixed up the order in which ingredients should be combined. How would you explain to the author why that matters?

____________________________________
____________________________________
____________________________________
____________________________________
____________________________________

124  Chapter Wrap-Up
The Mole

Before You Read

Define the following terms.

atomic mass

atomic mass unit (amu)

Chapter 2

Write the following in scientific notation

0.00582

24,367

400

Circle the significant figures in the numbers below.

75,600,000

0.00033

3.140
The Mole
Section 10.1 Measuring Matter

Main Idea

Scan Section 1, 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 questions that come to mind from your reading.

1. ______________________________________
2. ______________________________________
3. ______________________________________

New Vocabulary

mole

Avogadro’s number

Counting Particles

Use with page 320.

List three common counting units and their values.

1. ______________________________________
2. ______________________________________
3. _______________________________________
Section 10.1 Measuring Matter (continued)

**Main Idea**

Converting Between Moles and Particles

*Use with pages 320–321.*

**Details**

Describe why chemists needed to invent a new counting unit.

List three forms of substances that can be measured using moles.

1. ___________________________
2. ___________________________
3. ___________________________

Analyze the usefulness of a conversion factor.

Write the equation for finding the number of representative particles in a number of moles.

Explain how you would find the number of moles that are represented by a certain number of representative particles.
**Main Idea**

**Converting Particles to Moles**

*Use with Example Problem 10.1, page 324.*

**Details**

**Summarize** Fill in the blanks to help you take notes as you read Example Problem 10.1.

**Problem**

Convert $4.50 \times 10^{24}$ atoms of Zn to find the number of mol of Zn.

1. **Analyze the Problem**
   - Known: number of atoms = __________________
   - $1$ mole Zn = _________ atoms of Zn
   - Unknown: mole Zn = ________

2. **Solve for the Unknown**
   - the number of atoms $\times$ conversion factor = number of moles
   - _________ atoms Zn $\times$
   - $= \text{number of moles}$
   - $= \underline{\hspace{2cm}}$

3. **Evaluate the Answer**
   - The answer has ____ significant digits and is less than _______.

**Real-World Connection**

Suppose you were given each of the following tasks. Analyze which task(s) the mole would be an effective unit for counting. Explain your answer.

A. Counting the atoms in a single grain of salt.
B. Counting the grains of salt in a very large mine.
C. Counting the grains of salt in the world.

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________
The Mole
Section 10.2 Mass and the Mole

Main Idea

Details

Scan Section 2, using 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 this subject.

List four things you expect to learn from the chapter.

1. __________________________________________

2. __________________________________________

3. __________________________________________

4. __________________________________________

New Vocabulary

molar mass

Use your text to define this term.

____________________________________
The Mass of a Mole

Use with pages 325–326.

Analyze molar mass by completing the following statements.

The mass of one mole of carbon-12 atoms is ___ grams.
The mass of one mole of hydrogen is ___ gram and is _____ the mass of one mole of ______.
The mass of one mole of helium-4 is _____ the mass of one mole of ______ and is equal to ___ grams.
One mole of manganese is equal to ________ atoms of Mn.

Using Molar Mass

Use with pages 327–331.

Organize the following equations by drawing a line from type of conversion to the correct equation.

mole to mass  \[ \text{mass} \times \frac{1 \text{ mole}}{\text{number of grams}} \]

mass to mole  \[ \text{mass} \times \frac{1 \text{ mole}}{\text{number of grams}}, \]
             \[ \text{moles} \times \frac{6.02 \times 10^{23}}{1 \text{ mole}} \]

mass to atoms  \[ \text{number of moles} \times \frac{\text{number of grams}}{1 \text{ mole}} \]

atoms to mass  \[ \text{atoms} \times \frac{1 \text{ mole}}{6.02 \times 10^{23}}, \]
             \[ \text{moles} \times \frac{\text{number of grams}}{1 \text{ mole}} \]
Section 10.2 Mass and the Mole (continued)

Using Molar Mass
Mass to Atoms Conversion

Use with Example Problem 10.4, page 330.

Main Idea

You Try It

Problem
Determine how many atoms are in 10 g of pure copper (Cu).

1. Analyze the Problem
   Known: mass = ________
   Unknown: molar mass
             number of atoms

2. Solve for the Unknown
   Use the periodic table to find the atomic mass of copper and convert it to g/mol.
   Complete the conversion equations.
   mass Cu x conversion factor = moles Cu
   ________ × _____________ g Cu = ____ moles Cu
   moles Cu x conversion factor = atoms Cu
   ____ mol Cu × ________________________ atoms Cu

3. Evaluate the Answer
   Restate the answer with correct significant digits.
The Mole
Section 10.3 Moles of Compounds

Main Idea

Skim Section 3 of your text. Write three questions that come to mind from your reading.

1. ____________________________
2. ____________________________
3. ____________________________

Details

Chemical Formulas and the Mole
Use with pages 333–334.

Mole Relationships from a Chemical Formula
Use with Example Problem 10.6, page 334.

Describe the relationship between the mole information of a substance and its chemical formula.

Summarize Fill in the blanks to help you take notes as you read Problem 10.6.

Problem

Determine the number of moles of Al\(^{3+}\) ions in 1.25 moles of Al\(_2\)O\(_3\).

1. Analyze the Problem
   Known: number of moles of alumina = ____________
   Unknown: number of moles = ____________

2. Solve for the Unknown
   Write the conversion factor: \(\text{mol Al}^{3+}\) ions/\(\text{mol Al}_2\text{O}_3\)
   Multiply the known number of moles by the conversion factor.
   \(\text{mol Al}_2\text{O}_3 \times \text{mol Al}^{3+}\) ions/\(\text{mol Al}_2\text{O}_3\)
   = \(\text{mol Al}^{3+}\) ions

3. Evaluate the Answer
   Restate the answer with correct significant digits:
Section 10.3 Moles of Compounds (continued)

Main Idea

The Molar Mass of Compounds

Use with page 335.

Details

Describe the molar mass of a compound.

Investigate the process of finding molar mass by completing the table below.

<table>
<thead>
<tr>
<th>Number of Moles</th>
<th>Molar Mass</th>
<th>=</th>
<th>Number of Grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>mol K</td>
<td>g K/1 mol K</td>
<td></td>
<td>g</td>
</tr>
<tr>
<td>mol Cr</td>
<td>g Cr/1 mol Cr</td>
<td>=</td>
<td>g</td>
</tr>
<tr>
<td>mol O</td>
<td>g O/1 mol O</td>
<td></td>
<td>g</td>
</tr>
<tr>
<td>molar mass of K₂CrO₄</td>
<td>=</td>
<td>g</td>
<td></td>
</tr>
</tbody>
</table>

Converting Moles of a Compound to Mass

Use with page 336.

Analyze the process of converting moles of a compound to molar mass by completing the table below. Refer to Example Problem 10.7.

<table>
<thead>
<tr>
<th>Number of Moles</th>
<th>Molar Mass</th>
<th>=</th>
<th>Number of Grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 × 3 mol C</td>
<td>g C/1 mol C</td>
<td>=</td>
<td>g</td>
</tr>
<tr>
<td>2 × 5 mol H</td>
<td>g H/1 mol H</td>
<td>=</td>
<td>g</td>
</tr>
<tr>
<td>1 mol S</td>
<td>g S/1 mol S</td>
<td>=</td>
<td>g</td>
</tr>
<tr>
<td>molar mass of (C₃H₅)₂S</td>
<td>=</td>
<td>g</td>
<td></td>
</tr>
</tbody>
</table>
Section 10.3 Moles of Compounds (continued)

**Main Idea**

Converting the Mass of a Compound to Moles

*Use with page 337.*

Converting the Mass of a Compound to Number of Particles

*Use with page 338.*

**Details**

**Investigate** the process of converting the mass of a compound to moles by completing the following.

<table>
<thead>
<tr>
<th>Number of Moles</th>
<th>Molar Mass</th>
<th>=</th>
<th>Number of Grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 mol Ca</td>
<td>g Ca/1 mol Ca</td>
<td>=</td>
<td>g</td>
</tr>
<tr>
<td>2 × 1 mol O</td>
<td>g O/1 mol O</td>
<td>=</td>
<td>g</td>
</tr>
<tr>
<td>2 × 1 mol H</td>
<td>g H/1 mol H</td>
<td>=</td>
<td>g</td>
</tr>
<tr>
<td>molar mass of Ca(OH)$_2$</td>
<td>=</td>
<td>g</td>
<td></td>
</tr>
</tbody>
</table>

Conversion factor: ______ g of Ca(OH)$_2$/1 mol Ca(OH)$_2$

\[ g \text{ Ca(OH)}_2 \times \text{conversion factor} = \text{mol Ca(OH)}_2 \]

\[ \frac{\text{mol Ca(OH)}_2}{\text{mol Ca(OH)}_2} = \text{___ mol Ca(OH)}_2 \]

**Explain** the steps in converting the mass of a compound to number of particles.

1. Determine the ______.
2. Multiply by the ______ of the molar mass to convert to ______.
3. Multiply by _____________ to calculate the number of _____________.
4. Use the ratios from the _____________ to calculate the number of ___.
5. Calculate the _____ per formula unit.
Section 10.4 Empirical and Molecular Formulas

Skim Section 4 of your text. Write three questions that come to mind from reading the headings and the illustration captions.

1. 
2. 
3. 

Use your text to define each term.

percent composition

empirical formula

molecular formula
Write the equation for determining the percent by mass for any element in a compound.

Describe the general equation for calculating the percent by mass of any element in a compound.

Explain empirical formula by completing the following statements.
To determine the empirical ______ for a compound, you must first determine the smallest __________ of the moles of the elements in the compound. This ratio provides the _________ in the empirical formula. If the empirical formula differs from the molecular formula, the molecular formula will be a _____ multiple of the empirical formula. The data used to determine the chemical formula may be in the form of ______________ or it may be the actual masses. When the percent composition is given, you can assume that the total mass of the compound is 100.0 g to simplify calculations. The _____ of elements in a compound must be _________ to whole numbers to be used as _________ in the chemical formula.
Section 10.4 Empirical and Molecular Formulas (continued)

**Main Idea**

**Molecular Formula**

*Use with pages 346–349.*

**Details**

Explain how a molecular formula distinguishes two distinct substances sharing the same empirical formula.

Investigate molecular formulas by completing the steps below. Refer to Example Problem 10.12 in your text.

empirical formula = $\text{C}_2\text{H}_3\text{O}_2$

molar mass = 118.1 g/mol

Identify the molar mass of the compound.

<table>
<thead>
<tr>
<th>Moles of Element</th>
<th>Mass of Element/1 Mol of Element</th>
<th>=</th>
<th>Mass of Element</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 mol C</td>
<td>$\text{g C/mol C}$</td>
<td>=</td>
<td>$\text{g C}$</td>
</tr>
<tr>
<td>3 mol H</td>
<td>$\text{g H/mol H}$</td>
<td>=</td>
<td>$\text{g H}$</td>
</tr>
<tr>
<td>2 mol O</td>
<td>$\text{g O/mol O mol C/mol}$</td>
<td>=</td>
<td>$\text{g O}$</td>
</tr>
</tbody>
</table>

empirical molar mass of $\text{C}_2\text{H}_3\text{O}_2$ = $\text{g}$

Divide the molar mass of the substance by the molar mass of the compound to determine $n$.

$n = \frac{\text{molar mass of substance}}{\text{molar mass of compound}} = \frac{125}{118.1} = \text{ }$

Multiply the subscripts in the empirical formula by $n$. Write the molecular formula.
Examine the flow chart below. Write the steps in determining empirical and molecular formulas from percent composition or mass data next to the relevant boxes in the flow chart.
The Mole
Section 10.5 Formulas of Hydrates

Main Idea

Detailed

Skim Section 5 of your text. Write three questions that come to mind from reading the headings and the illustration captions.

1.

2.

3.

New Vocabulary

hydrate

Use your text to define the following term.

Naming Hydrates

Use with page 351.

Explain how hydrates are named by completing the table below.

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Molecules of Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>mono-</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>8</td>
</tr>
<tr>
<td>nona-</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>10</td>
</tr>
</tbody>
</table>
Section 10.5 Formulas of Hydrates (continued)

Main Idea

Analyzing a Hydrate

Use with page 352.

Determining the Formula of a Hydrate


Details

Describe an anhydride.

Solve Read Example Problem 10.14 in your text.

You Try It

Problem

A 5.00 g sample of barium chloride hydrate was heated in a crucible. After the experiment, the mass of the solid weighed 4.26 g. Determine the number of moles of water that must be attached to BaCl₂.

1. Analyze the Problem

Known: mass of hydrated compound = ___ g BaCl₂ \cdot x H₂O

mass of anhydrous compound = ___ g BaCl₂

molar mass of H₂O = ___ g/mol

molar mass of BaCl₂ = 208.23 g/mol

Unknown: formula for hydrate

name of hydrate
2. Solve for the Unknown
Subtract the mass of the anhydrous compound from the hydrated compound.

Calculate the number of moles of $\text{H}_2\text{O}$ and anhydrous $\text{BaCl}_2$ using the conversion factor that relates moles and mass based on the molar mass.

$4.26 \text{ g BaCl}_2 \times \frac{\text{?}}{\text{H}_2\text{O}} \times \frac{\text{?}}{\text{BaCl}_2}$

$0.84 \text{ g H}_2\text{O} \times \frac{\text{?}}{\text{H}_2\text{O}} \times \frac{\text{?}}{\text{BaCl}_2}$

Determine the value of $x$.

$x = \frac{\text{moles H}_2\text{O}}{\text{moles BaCl}_2} = \text{?} = \text{?}$

3. Evaluate the Answer
The ratio of $\text{H}_2\text{O}$ to $\text{BaCl}_2$ is ____ so the formula for the hydrate is ____________, and the name of the hydrate is ______ _______.

---

**REAL-WORLD CONNECTION**

Explain why hydrates are useful in storage and shipping.

---

The Mole 141
Now that you have read the chapter, review what you have learned and list three things you have learned about moles.

1. __________________________________________

2. __________________________________________

3. __________________________________________

Use this checklist to help you study.

☐ Study your Science Notebook for this chapter.

☐ Study the definitions of vocabulary words.

☐ Review daily homework assignments.

☐ Reread the chapter and review 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.

Summarize the important conversions you have learned in this chapter.
Stoichiometry

Before You Read

Define the following terms.

- mole
- molar mass
- conversion factor
- dimensional analysis
- law of conservation of mass

Balance the following equation.

\[ \boxed{\text{Mg (s)}} + \boxed{\text{AlCl}_3 (aq)} \rightarrow \boxed{\text{Al (s)}} + \boxed{\text{MgCl}_2 (aq)} \]

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

<table>
<thead>
<tr>
<th>Pure Substance</th>
<th>Molar Mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>12.011</td>
</tr>
<tr>
<td></td>
<td>22.990</td>
</tr>
<tr>
<td></td>
<td>15.999</td>
</tr>
<tr>
<td>Sodium carbonate</td>
<td></td>
</tr>
</tbody>
</table>
**Stoichiometry**

**Section 11.1 Defining Stoichiometry**

<table>
<thead>
<tr>
<th>Main Idea</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Skim</strong> Section 1 of your text. Write three questions that come to mind from reading the headings and the illustration captions.</td>
<td></td>
</tr>
<tr>
<td>1. __________________________________________</td>
<td></td>
</tr>
<tr>
<td>2. __________________________________________</td>
<td></td>
</tr>
<tr>
<td>3. __________________________________________</td>
<td></td>
</tr>
</tbody>
</table>

**New Vocabulary**

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>stoichiometry</td>
<td>Use your text to define each term.</td>
</tr>
<tr>
<td>mole ratio</td>
<td></td>
</tr>
</tbody>
</table>

**Academic Vocabulary**

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>derive</td>
<td>Define the following term.</td>
</tr>
</tbody>
</table>

**Particle and Mole Relationships**

*Use with page 368.*

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

1. __________________________________________
2. __________________________________________
3. __________________________________________
Section 11.1 Defining Stoichiometry (continued)

**Main Idea**

Interpreting Chemical Equations

*Use with Example Problem 11.1, page 370.*

**Details**

**Problem**

Interpret the equation in terms of ________________, and ____. Show that the law of conservation of mass is ________.

1. **Analyze the Problem**

   Known:
   
   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.

   \[ \text{moles of reactant} \times \frac{\text{grams of reactant}}{1 \text{ mole of reactant}} = \text{grams of ________} \]

   \[ \text{moles of product} \times \frac{\text{grams of reactant}}{1 \text{ mole of reactant}} = \text{grams of ________} \]

   Add the masses of the reactants.

   \[ \underline{\boxed{\text{g } C_3H_8}} + \underline{\boxed{\text{g } O_2}} = \boxed{\text{g reactants}} \]

   Add the masses of the products.

   \[ \underline{\boxed{\text{g } CO_2}} + \underline{\boxed{\text{g } H_2O}} = \boxed{\text{g products}} \]

   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 \[ \underline{\boxed{\text{significant figures}}} \] significant figures. Your answer must have \[ \underline{\boxed{\text{significant figures}}} \] significant figures.
Defining Stoichiometry

Main Idea

Mole ratios
Use with pages 371–372.

Details

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

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

$$\text{C}_2\text{H}_4(g) + 3\text{O}_2(g) \rightarrow 2\text{CO}_2(g) + 2\text{H}_2\text{O}(l)$$

Write the mole ratios for the above equation.
Stoichiometry
Section 11.2 Stoichiometric Calculations

Main Idea

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. ____________________________________________

Identify the tools needed for stoichiometric calculations.
All stoichiometric calculations start with _________ based on a __________________________. Finally, __________________________ are required.
**Main Idea**

**Mole-to-Mass Stoichiometry**

*Use with Example Problem 11.3, page 376.*

**Details**

**Solve**  *Read Example Problem 11.3 in your text.*

**You Try It**

**Problem**

How many grams of solid iron (III) chloride (FeCl₃) are produced when 2.00 moles of solid iron (Fe) are combined with chlorine gas (Cl₂)?

1. **Analyze the Problem**

   **Known:**

   **Unknown:**

   You are given the moles of the reactant, Fe, and must determine the mass of the product, FeCl₃, 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.

   \[
   \text{Fe(s)} + \text{Cl}_2(g) \rightarrow \text{FeCl}_3(s)
   \]

   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 FeCl₃.

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

   \[
   \frac{\text{mol Fe}}{\text{mol FeCl}_3} \times \text{mol FeCl}_3 = \text{mol FeCl}_3
   \]

   Multiply the moles of FeCl₃ by the molar mass of FeCl₃.

   \[
   \frac{\text{mol FeCl}_3}{1 \text{ mol FeCl}_3} \times \text{g FeCl}_3 = \text{g FeCl}_3
   \]

3. **Evaluate the Answer**

   The given number of moles has \(\square\) digits, so the mass of FeCl₃ must have \(\square\) digits.
**Mole-to-Mole Stoichiometry**

*Use with Example Problem 11.2, page 375.*

### Main Idea

#### Solve

Read Example Problem 11.2 in your text.

#### You Try It

**Problem**

How many moles of aluminum oxide (Al\(_2\)O\(_3\)) 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.

   \[
   \boxed{\text{Al(s)}} + \boxed{\text{O}_2(g)} = \boxed{\text{Al}_2\text{O}_3(s)}
   \]

   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\(_2\)O\(_3\).

   Multiply the known number of moles Al by the mole ratio to find the moles of unknown Al\(_2\)O\(_3\).

   \[
   \boxed{\text{moles of Al}} \times \boxed{\text{moles of Al}_2\text{O}_3} = \boxed{\text{moles of Al}_2\text{O}_3}
   \]

3. **Evaluate the Answer**

   The given number of moles has \boxed{ significant figures. Therefore, the answer must have \boxed{ significant figures.}
Mass-to-Mass Stoichiometry

Use with Example Problem 11.4, page 377.

Solve Read Example Problem 11.4 in your text.

You Try It

Problem

Determine the mass of ammonia (NH₃) produced when 3.75 g of nitrogen gas (N₂) react with hydrogen gas (H₂).

1. Analyze the Problem

Known: __________

Unknown: __________

You are given the mass of the reactant, N₂, and must determine the mass of the product NH₃. Do a mass-to-mass conversion.

2. Solve for the Unknown

Write the balanced chemical equation for the reaction.

N₂(g) + H₂(g) = NH₃(g)

Convert grams of N₂(g) to moles of N₂(g) using the inverse of molar mass as the conversion factor.

g N₂(g) × 1 mol N₂ = mol N₂

List the mole ratios for this equation.

Multiply moles of N₂ by the mole ratio that relates N₂ to NH₃.

mol N₂ × mol NH₃ = mol NH₃

Multiply moles of NH₃ by the molar mass.

mol NH₃ × g NH₃ = g NH₃

3. Evaluate the Answer

The given mass has _____ significant figures, so the mass of NH₃ must have _____ significant figures.
**Stoichiometric Problem Solving**

*Use with page 374.*

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

1. **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.
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. ________________________________

Use your text to define each term.

limiting reactant

excess reactant
**Main Idea**

**Why do Reactions Stop?**

Use with pages 379–380.

**Calculating the Product When a Reactant is Limiting**

Use with pages 380–381.

---

**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 11.5 in your text.

**You Try It**

**Problem**

If 100.0 g of sulfur reacts with 50.0 g 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 11.3 Limiting Reactants (continued)

Main Idea

- 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.

Details

- 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 11.4 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.

In the left margin, write the terms defined below.

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.

Write the formula for percent yield.

\[ \frac{\text{actual yield (from an experiment)}}{\text{theoretical yield (from stoichiometric calculations)}} \times 100 = \text{percent yield} \]
Section 11.4 Percent Yield (continued)

Main Idea

Percent Yield
Use with page 386.

Details

Solve Read Example Problem 11.6 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.

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

<table>
<thead>
<tr>
<th>Review</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use this checklist to help you study.</td>
</tr>
<tr>
<td>☐ Use this Science Notebook to study this chapter.</td>
</tr>
<tr>
<td>☐ Study the vocabulary words and scientific definitions.</td>
</tr>
<tr>
<td>☐ Review daily homework assignments.</td>
</tr>
<tr>
<td>☐ Reread the chapter, reviewing the tables, graphs, and illustrations.</td>
</tr>
<tr>
<td>☐ Review the Section Assessment questions at the end of each section.</td>
</tr>
<tr>
<td>☐ Look over the Study Guide at the end of the chapter.</td>
</tr>
</tbody>
</table>

**REAL-WORLD CONNECTION**

Explain how stoichiometry is important to air bags and your safety.
States of Matter

Before You Read

Review Vocabulary

Define the following terms.

- gas

- physical property

Chapter 2

Calculate the density of a sample with a mass of 22.5 g and a volume of 5.0 cm$^3$. Use the equation: density = mass/volume.

Chapter 3

Describe the two essential characteristics that determine the chemical and physical properties of matter.

Compare and contrast the chemical and physical properties of gases.
States of Matter
Section 12.1 Gases

Main Idea

Scan Section 1, using 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 this subject.

New Vocabulary

kinetic-molecular theory

elastic collision

temperature

diffusion

Graham’s law of effusion

pressure

barometer

pascal

atmosphere

Dalton’s law of partial pressures

Use your text to define each term.
Main Idea

The Kinetic-Molecular Theory

Explaining the Behavior of Gases

Details

Distinguish between the three main physical properties of gas particles by completing the passages below.

1. Size is very ____. It is assumed that there are ___ significant _______ or _______ forces among gas particles.

2. Motion is _______ moving in a _______ pattern. It is assumed that gas particles move in a _______ path until they ________.

3. Energy is _______. It is assumed that ___ and ______ impact the _____ level of a gas _____.

Describe kinetic energy in equation form by completing the table below.

<table>
<thead>
<tr>
<th>$KE = \frac{1}{2}mv^2$</th>
<th>Variable</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>$KE$</td>
<td>$m$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$v$</td>
<td></td>
</tr>
</tbody>
</table>

Describe the following concepts as they relate to the behaviors of gases by completing the passages below.

low density—Gases have low density (____ per _______) in comparison to _____. The difference in density is partly due to the mass of the _______ and also because there is a great deal of _____ between gas particles.

compression and expansion—The large amount of _______ between gas particles allows them to be ________, or pushed, into a _____ volume. Once the pressure is _______, the particles _______ to the original _______.

diffusion and effusion—Because there are no _______ forces of _______ between gas particles, gases ________ past one another. This ______ motion allows gases to mix until they are ___________. The movement of _______ past one another is called _______. The process of allowing a gas to escape from a more concentrated container is called _______.

States of Matter  161
Main Idea

Write Graham’s law of effusion as a proportional statement.

Write the proportional statement based on Graham’s law of effusion that allows you to compare the diffusion rate of two different gases.

Details

Describe pressure as it relates to the behaviors of gases.

Distinguish between a barometer and a manometer.

Explore the relationship between different units of pressure by filling in the table below.

<table>
<thead>
<tr>
<th>Unit Name (unit symbol)</th>
<th>Conversion Ratio: 1 atm =</th>
<th>Conversion Ratio: 1 kPa =</th>
</tr>
</thead>
<tbody>
<tr>
<td>kilopascal (kPa)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>millimeters of mercury (mmHg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>torr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pounds per square inch (psi)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>atmosphere (atm)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
States of Matter
Section 12.2 Forces of Attraction

Main Idea

Details

Skim Section 2 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.

dispersion forces

dipole-dipole force

hydrogen bond

Academic Vocabulary

Define the following term.

orient
Section 12.2 Forces of Attraction (continued)

Intermolecular Forces
Use with pages 411–414.

Describe the difference between an intramolecular and an intermolecular force.

Compare and contrast intramolecular forces by completing the table below.

<table>
<thead>
<tr>
<th>Force</th>
<th>Basis of Attraction</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ionic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Covalent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metallic</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Compare intermolecular forces by completing the table below.

<table>
<thead>
<tr>
<th>Force</th>
<th>Basis of Attraction</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dispersion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dipole-dipole</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrogen bond</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
States of Matter
Section 12.3 Liquids and Solids

Scan Section 3, using 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 this subject.

New Vocabulary

Use your text to define each term.

- **viscosity**

- **surface tension**

- **surfactant**

- **crystalline solid**

- **unit cell**

- **allotrope**

- **amorphous solid**
Liquids

Use with pages 415–419.

**Main Idea**

**Details**

Compare and contrast the following paired concepts as they relate to the properties of liquids by completing the following statements.

**Density and compression:** A liquid can take the __________ _______, but its volume is __________. The density of a liquid is __________ than the density of the same substance as a __________. Liquids cannot usually be __________ except under __________ pressure.

**Fluidity and viscosity:** Fluidity is the ability to __________. Liquids flow through each other but at a __________ than __________ do. Viscosity is the measure of the __________ of a liquid to __________. The stronger __________ slow down the ability to flow, which __________ resistance (viscosity).

**Viscosity and temperature:** Temperature affects the __________ of a __________. Viscosity __________ with temperature.

**Analyze** the relationship between viscosity, temperature, and change in kinetic energy by completing the table.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Δ KE</th>
<th>Viscosity</th>
<th>Effect in Liquid</th>
</tr>
</thead>
<tbody>
<tr>
<td>increases</td>
<td></td>
<td></td>
<td>flows faster</td>
</tr>
<tr>
<td>decreases</td>
<td></td>
<td>increases</td>
<td></td>
</tr>
<tr>
<td>stays the same</td>
<td>no change</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Describe the following concepts as they relate to the properties of liquids by completing the following passages.

Capillary action is ____________________________

____________________________________________

Cohesion is ____________________________

Adhesion is ____________________________

**Describe** the following concepts as they relate to the properties of liquids by completing the following passages.

Capillary action is ____________________________

____________________________________________

Cohesion is ____________________________

Adhesion is ____________________________

**Describe** the following concepts as they relate to the properties of liquids by completing the following passages.

Capillary action is ____________________________

____________________________________________

Cohesion is ____________________________

Adhesion is ____________________________
Contrast the density of solids and liquids by completing the following paragraph.

In general, the ______ in a solid are more ______—that is, more dense—than those in a ______. When liquid and solid states of the same substance exist at the same time, the ______ usually ______ in the ______. One familiar exception is ______.

When water is in its solid state as ice, it ______, such as ______ or a(n) ______. This is because there is ______ space between the ______ in ice than in liquid water.

Compare the different types of crystalline solids by completing the following table.

<table>
<thead>
<tr>
<th>Type</th>
<th>Unit Particles</th>
<th>Characteristics</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atomic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molecular</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Covalent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>network</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ionic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metallic</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# States of Matter

## Section 12.4 Phase Changes

**Main Idea**

**Details**

*Skim Section 4 of your text. Write a brief summary of the main topics covered.*

<table>
<thead>
<tr>
<th>New Vocabulary</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>vapor pressure</td>
<td>Use your text to define each term.</td>
</tr>
<tr>
<td>boiling point</td>
<td></td>
</tr>
<tr>
<td>condensation</td>
<td></td>
</tr>
<tr>
<td>deposition</td>
<td></td>
</tr>
<tr>
<td>phase diagram</td>
<td></td>
</tr>
<tr>
<td>melting point, freezing point, and triple point</td>
<td></td>
</tr>
<tr>
<td>vaporization and evaporation</td>
<td></td>
</tr>
</tbody>
</table>

*Compare and contrast the following terms using your text as a guide.*

*Main Idea*

*Details*
Section 12.4 Phase Changes (continued)

**Main Idea**

**Phase Changes That Require Energy**

*Use with page 425.*

**Details**

**Classify** the types of phase changes by completing the table below. *Use Figure 12.23 in your text for reference.*

<table>
<thead>
<tr>
<th>Phase Transition</th>
<th>Type of Transition</th>
</tr>
</thead>
<tbody>
<tr>
<td>gas to solid</td>
<td></td>
</tr>
<tr>
<td>solid to liquid</td>
<td></td>
</tr>
<tr>
<td>liquid to gas</td>
<td></td>
</tr>
<tr>
<td>liquid to solid</td>
<td>condensation</td>
</tr>
<tr>
<td>solid to gas</td>
<td></td>
</tr>
</tbody>
</table>

**Describe** the phase changes that require energy by completing the following outline.

I. Melting
   A. Heat energy disrupts ________________________________.
   B. The amount of energy required depends on ________________________________.
   C. The melting point is the temperature at which ________________________________.
   D. The melting point of ________________________________ may be unspecified.

II. Vaporization
   A. In liquid water, some particles have more ________________________________.
   B. Particles that escape from liquid enter the ________________________________.
   C. When vaporization occurs only at a surface it is called ________________________________.
   D. The pressure exerted by a vapor over liquid is called ________________________________.
   E. The temperature at which vapor pressure equals atmospheric pressure is called the ________________________________.

III. Sublimation
   A. Many solids can become gases without ________________________________.
   B. Some solids sublime at ________________________________.
   C. The process of ________________________________ is an example of sublimation.
Section 12.4 Phase Changes (continued)

**Main Idea**

Phase Changes That Release Energy

*Use with pages 428–429.*

**Details**

Organize the phase changes that release energy. Identify the phase, describe the process, and identify the reverse process by completing the table below.

<table>
<thead>
<tr>
<th>Phase Change</th>
<th>Process Description</th>
<th>Reverse Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>condensation</td>
<td>process in which a liquid becomes a solid</td>
<td>vaporization</td>
</tr>
<tr>
<td>deposition</td>
<td></td>
<td>sublimation</td>
</tr>
</tbody>
</table>

**Phase Diagrams**

*Use with pages 429–430.*

Explain how the critical point affects water.

Identify normal freezing point, normal boiling point, critical point, and triple point in the phase diagram for H₂O below. Use Figure 12.30 in your text for reference.

![Phase Diagram for H₂O](image-url)
After reading this chapter, list three key equations and relationships.

1. 
2. 
3. 

Review

Use this checklist to help you study.

☐ Study your Science Notebook for this chapter.
☐ Study the definitions of vocabulary words.
☐ Review daily homework assignments.
☐ Reread the chapter and review 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

You see examples of phase changes every day. Use your text to identify which phase change each of the following transitions demonstrates. The first one has been done for you.

frost forms on a windowpane deposition

ice becomes water

steam rises from a cup of coffee

a water pipe bursts on a very cold day

drops of water cover the mirror after a shower

snow melts without leaving a puddle
Gases

Before You Read

Review Vocabulary

Define the following terms.

- density
- stoichiometry
- kinetic-molecular theory

Chapter 9

Balance the following equation.

\[ \_\_Fe + \_\_H_2SO_4 \rightarrow Fe_2(SO_4)_3 + \_\_H_2 \]

Chapter 11

Show the mole ratios for the following reaction.

\[ N_2 + 3H_2 \rightarrow 2NH_3 \]

a. mole ratio of N to H

b. mole ratio of NH to H

Chapter 12

Explain how gas particles exert pressure.
Gases
Section 13.1 The Gas Laws

Scan Section 1 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 this subject.

Write three facts you discovered about the gas laws.
1. __________________________________________
2. __________________________________________
3. __________________________________________

New Vocabulary

Boyle’s law

Use your text to define each term.

absolute zero

Charles’s law

Gay-Lussac’s law

combined gas law
Section 13.1 The Gas Laws (continued)

**Main Idea**

**Boyle’s Law**

*Use with page 443.*

**Details**

**Solve** Read Example Problem 13.1 in your text.

**You Try It**

**Problem**

Helium gas in a balloon is compressed from 4.0 L to 2.5 L at constant temperature. The gas’s pressure at 4.0 L is 210 kPa. Determine the pressure at 2.5 L.

1. **Analyze the Problem**
   
   Known: Unknown:
   
   \[ V_1 = \quad P_2 \quad \]
   
   \[ V_2 = \quad \]
   
   \[ P_1 = \quad \]
   
   Use the equation for Boyle’s law to solve for \( P_2 \).

2. **Solve for the Unknown**

   Write the equation for Boyle’s law:
   
   \[ \frac{P_1}{V_1} = \frac{P_2}{V_2} \]
   
   To solve for \( P_2 \), divide both sides by \( V_2 \).
   
   \[ P_2 = \]
   
   Substitute the known values.
   
   \[ P_2 = \]
   
   Solve for \( P_2 \).
   
   \[ P_2 = \quad \]

3. **Evaluate the Answer**

   When the volume is ________, the pressure is ________.

   The answer is in ________, a unit of pressure.
Charles’s Law

Use with Example Problem 13.2, page 446.

Summarize Fill in the blanks to help you take notes while you read Example Problem 13.2.

A gas sample at 40.0°C occupies a volume of 2.32 L. Assuming the pressure is constant, if the temperature is raised to 75.0°C, what will the volume be?

1. Analyze the Problem

Known: Unknown:

\( T_1 = \) \( V_1 = \) \( V_2 = \) \( T_2 = \)

Use Charles’s law and the known values for \( T_1, V_1, \) and \( T_2 \) to solve for \( V_2 \).

2. Solve for the Unknown

Convert the \( T_1 \) and \( T_2 \) Celsius temperatures to kelvin:

\( T_1 = 273 + 40.0^\circ C = \) \( K \)

\( T_2 = 273 + 75.0^\circ C = \) \( K \)

Write the equation for Charles’s law:

\[ V_1 \frac{T_1}{T_2} = \]

To solve for \( V_2 \), multiply both sides by \( T_2 \):

\[ V_2 = \]

Substitute known values:

\[ V_2 = \]

Solve for \( V_2 \).

\[ V_2 = \]

3. Evaluate the Answer

When temperature in kelvin increases by a small amount, the volume \( \) by a small amount. The answer is in \( \), a unit for volume.
**Gay-Lussac’s Law**

Use with Example Problem 13.3, page 448.

**Main Idea**

Gay-Lussac’s Law

**Details**

**Solve** Read Example Problem 13.3 in your text.

**You Try It**

**Problem**

The pressure of a gas stored in a refrigerated container is 4.0 atm at 22.0°C. Determine the gas pressure in the tank if the temperature is lowered to 0.0°C.

1. **Analyze the Problem**
   Known: Unknown:
   \( P_1 = 4.0 \text{ atm} \) \( P_2 = ? \)
   \( T_1 = \) \( T_2 = \)

   Use Gay-Lussac’s law and the known values for \( T_1, V_1, \) and \( T_2 \) to solve for \( V_2 \).

2. **Solve for the Unknown**
   Convert the \( T_1 \) and \( T_2 \) Celsius figures to kelvin.
   \( T_1 = \) \( 22.0°\text{C} = \) \( \text{K} \)
   \( T_2 = 273 + \) \( \text{K} \)

   Write the equation for Gay-Lussac’s law.

   To solve for \( P_2 \), multiply both sides by \( T_2 \).
   \[ P_2 = \]

   Substitute known values.
   \[ P_2 = \]

   Solve for \( P_2 \).
   \( P_2 = 3.7 \text{ atm} \)

3. **Evaluate the Answer**
   The temperature \( \) and the pressure \( \) .
The Combined Gas Law

Description: The combined gas law is used to describe the relationship between pressure, volume, and temperature of a gas in a closed system.

Write the combined gas law equation.

Pressure is inversely proportional to ______ and directly proportional to ______. Volume also is ______________ to temperature.

Solve: Read Example Problem 14.4 in your text.

You Try It

Problem

A gas at 100.0 kPa and 30.0°C has an initial volume of 1.00 L. Determine the temperature that could support the gas at 200.0 kPa and a volume of 0.50 L.

1. Analyze the Problem

   - Known:
     - $P_1 = _____$
     - $T_1 = _____$
     - $V_1 = _____$
   - Unknown:
     - $T_2 = ? ^\circ C$
     - $P_2 = _____$
     - $V_2 = _____$

   Remember that volume increases as temperature increases, and volume is inversely proportional to pressure.

2. Solve for the Unknown

   Convert the $T_1$ Celsius temperature to kelvin.
   
   $T_1 = ____ + 30.0^\circ C = ____ K$
Write the combined gas law equation.

To solve for \( T_2 \), multiply both sides of the equation by \( T_2 \).

\[
\frac{T_1}{P_2 V_2} = T_1
\]

Multiply both sides of the equation by \( T_1 \).

\[
T_2 P_1 V_1 = \text{________}
\]

Divide both sides of the equation by \( P_1 V_1 \).

\[
T_2 = \text{________}
\]

Substitute known values.

\[
T_2 = \frac{100.0 \text{ kPa} \times 1.00 \text{ L}}{100.0 \text{ kPa} \times 1.00 \text{ L}}
\]

Solve for \( T_2 \).

\[
T_2 = 303 \text{ K} - 273 \text{ K} = 30.0 \text{°C}
\]

3. Evaluate the Answer

As pressure _______ and volume _______ in proportional amounts, the temperature remained constant.
Gases
Section 13.2 The Ideal Gas Law

**Main Idea**

**Details**

**Skim Section 2 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.**

*Avogadro’s principle*

* molar volume

*ideal gas constant (R)*

*ideal gas law*
Section 13.2 The Ideal Gas Law (continued)

**Main Idea**

**Avogadro's Principle**

*Use with pages 452–453.*

**Details**

Explain *Avogadro’s principle by completing the paragraph below.*

Avogadro’s principle states that ________________.

The _____ volume for a gas is the volume that one mole occupies at ______ of pressure and a temperature of ______.

Convert the following volumes of a gas at STP to moles by using 22.4 L/mol as the conversion factor.

\[
2.50 \text{ L} \times \frac{1 \text{ mol}}{22.4 \text{ L}} = \quad \text{__________}
\]

\[
7.34 \text{ L} \times \frac{1 \text{ mol}}{22.4 \text{ L}} = \quad \text{__________}
\]

\[
4.7 \text{ L} \times \frac{1 \text{ mol}}{22.4 \text{ L}} = \quad \text{__________}
\]
The Ideal Gas Law

Use with pages 454–455.

Analyze the ideal gas law.
The equation is written \( \frac{P}{V} = \frac{n}{R} \).

- \( P \) represents ________
- \( V \) represents ________
- \( n \) represents the number of _____ of gas present
- \( R \) represents the ________________
- ____ represents temperature

The ideal gas law states that _________________________________

_________________________ _________________

_______________. The value of \( R \) depends on the units used for ________.

Describe the properties of an ideal gas.

_________________________

_________________________

Describe the properties of a real gas.

_________________________

_________________________
The Ideal Gas Law

Use with Example Problem 13.6, page 455.

**Summarize** Fill in the blanks to help you take notes while you read Example Problem 13.6.

**Problem**
Calculate the number of moles of a gas contained in a 3.0-L vessel at \(3.00 \times 10^2\) K with a pressure of 1.50 atm.

1. **Analyze the Problem**
   - Known:
     - \(V = \) _____
     - \(T = \) _____
     - \(P = \) _____
     - \(R = \) _____
   - Unknown:
     - \(n = \) ? mol
   - Use the known values to find the value of \(n\).

2. **Solve for the Unknown**
   - Write the ideal gas law equation.
     
     \[
     \frac{n}{V} \cdot \frac{P}{R} = \frac{T}{T}
     \]
   - To solve for \(n\), divide both sides by \(RT\).
     
     \[
     n = \frac{P \cdot V}{R \cdot T}
     \]
   - Substitute known values into the equation.
     
     \[
     n = \frac{1.50 \text{ atm} \times 3.0 \text{ L}}{0.0821 \text{ L} \cdot \text{atm} \cdot \text{K}^{-1} \cdot \text{mol}^{-1} \times 300 \text{ K}}
     \]
   - Solve for \(n\).
     
     \[
     n = \frac{4.5}{8.93}
     \]

3. **Evaluate the Answer**
   - The answer agrees with the prediction that the number of moles will be _______ one mole. The unit in the answer is the _____.
Gases
Section 13.3 Gas Stoichiometry

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 this subject.

Write three facts you discovered about gas stoichiometry.

1. 

2. 

3. 

Define the following terms.

ratio
Section 13.3 Gas Stoichiometry (continued)

**Main Idea**

**Stoichiometry and Volume–Volume Problems**

Use with page 460.

**Details**

**Indicate** the moles and volume for the reaction below. Use Figure 13.10 as a reference.

\[ 2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(g) \]

<table>
<thead>
<tr>
<th>moles</th>
<th>moles</th>
<th>moles</th>
<th>moles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>volumes</th>
<th>volumes</th>
<th>volumes</th>
<th>volumes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The coefficients in the balanced equation represent ____ amounts and relative _____.

**Summarize** Fill in the blanks to help you take notes while you read Example Problem 13.7.

**Problem**

Determine the volume of oxygen gas needed for the complete combustion of 4.00 L of propane gas (C₃H₈).

1. **Analyze the Problem**
   
   **Known:**
   
   \( V \) of \( C_3H_8 \) = ______  

   **Unknown:**
   
   \( V \) of \( O_2 \) = ? L
   
   Use the known volume of 4.00 L to find the volume needed for the combustion.

2. **Solve for the Unknown**
   
   Write the balanced equation for the combustion of \( C_3H_8 \).
   
   \[ \underline{________} \]
   
   Write the volume ratio.
   
   Multiply the known volume of propane by the volume ratio to find the volume of \( O_2 \).

3. **Evaluate the Answer**
   
   The coefficients of the reactants show that the quantity of _____ consumed is greater than the amount of propane. The unit of the answer is the _____, a unit of volume.
Gases  Chapter Wrap-Up

After reading the chapter, review what you have learned. Match each of the gas laws with its equation.

___ Ideal gas law  

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

___ Gay-Lussac’s law  

$$P_1 V_1 = P_2 V_2$$

___ Charles’s law  

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

___ Combined gas law  

$$PV = nRT$$

___ Boyle’s law  

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

Review

Use this checklist to help you study.

☐ Study your Science Notebook for this chapter.

☐ Study the vocabulary words and scientific definitions.

☐ Review daily homework assignments.

☐ Reread the chapter and review 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

Explain why the volume of a balloon increases as you blow into it instead of bursting immediately from the added pressure.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

186  Chapter Wrap-Up
Mixtures and Solutions

Before You Read

Review Vocabulary

Define the following terms.

alloy

solution

Chapter 3

Compare and contrast a homogeneous mixture with a heterogeneous mixture.

Chapter 8

Explain why water is a polar molecule. Include a labeled drawing of a water molecule in your answer.

Chapter 10

Describe the relationship between moles and molar mass.
Mixtures and Solutions
Section 14.1 Types of Mixtures

Scan Section 1 of your text, using 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 solutions.

Identify the unifying theme of this section.

Use your text to define each term.

**New Vocabulary**
suspension

colloid

Brownian motion

Tyndall effect

Compare and contrast soluble and insoluble substances.

Compare and contrast miscible and immiscible liquids.
Section 14.1 Types of Mixtures (continued)

**Main Idea**

**Suspensions**

*Use with page 476.*

**Details**

**List** three properties of a suspension.
1. 
2. 
3. 

**State** three examples of suspensions.
1. 
2. 
3. 

**Colloids**

*Use with pages 477–479.*

**Identify** four properties of a colloid.
1. 
2. 
3. 
4. 
Section 14.1 Types of Mixtures (continued)

Main Idea

Explain why particles in Brownian motion do not settle out.

Details

Identify each of the following mixtures as a suspension, dilute colloid, or concentrated colloid. Base your answers on the property described.

<table>
<thead>
<tr>
<th>Property</th>
<th>Type of Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>cloudy mixture with particles that move erratically</td>
<td></td>
</tr>
<tr>
<td>large particles with thixotropic behavior</td>
<td></td>
</tr>
<tr>
<td>clear mixture with particles that scatter light</td>
<td></td>
</tr>
</tbody>
</table>

Real-World Connection

Describe the properties of fog in terms of being a mixture and why those properties make driving through fog so dangerous.
Mixtures and Solutions
Section 14.2 Solution Concentration

Scan Section 2 of your text, using 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 this subject.

Write three facts you discovered about solutions.

1. 
2. 
3. 

Use your text to define these terms.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>concentration</td>
<td></td>
</tr>
<tr>
<td>molarity</td>
<td></td>
</tr>
<tr>
<td>molality</td>
<td></td>
</tr>
<tr>
<td>mole fraction</td>
<td></td>
</tr>
</tbody>
</table>

Define the following term.

concentrated
Section 14.2 Solution Concentration

Main Idea

Expressing Concentration
Use with pages 480–481.

Details

Analyze the similarities in all of the concentration ratios shown in Table 14.3 in your text.

Write the equation for determining percent by mass.

Percent by mass =

Summarize Fill in the blanks to help you take notes as you read Example Problem 14.1.

Problem Determine the percent by mass of 3.6 g NaCl in 100.0 g H₂O.

1. Analyze the Problem
   List the knowns and unknowns.
   Known: Unknown:
   mass of solute = ________ percent by mass = ?
   mass of solvent = ________

2. Solve for the Unknown
   Find the mass of the solution.
   mass of solution = grams of solute + grams of solvent
   mass of solution = 3.6 g + ______ = ______
   Substitute the known values into the percent by mass equation.
   percent by mass =

3. Evaluate the Answer
   The answer should be a small percent, to match the small quantity of _____.
   The mass of sodium chloride was given in two significant figures, therefore, the answer should have ___ significant figures.
**Main Idea**

**Molarity**

*Use with pages 482–485.*

**Details**

**Describe** how to calculate the molarity of a solution by completing the following statements.

To calculate the ______ of a solution, you must know the amount of dissolved ______ and the volume of ______. The following equation is used: molarity \((M) = \) ______ of solute/liters of ______.

**Explain** why you may need less than one liter of water to prepare a molar solution of one liter.

**Write** the expression that describes the relationship between a stock solution and a dilute solution.

\[ M_1 = \] ______

\[ V_1 = \] ______

\[ M_2 = \] ______

\[ V_2 = \] ______
Section 14.2 Solution Concentration (continued)

**Main Idea**

**Molality and Mole Fraction**

*Use with pages 487–488.*

**Details**

**Explain** how the volume and mass of a solution change with temperature.

The volume may _____ when heated or _____ when cooled.

The mass of the solution ______ change.

**Write** the mole fraction equations for a solvent (\(X_A\)) and a solute (\(X_B\)) below.

\[ X_A = \quad \quad \quad X_B = \]

**Evaluate** the mole fraction for the values given in problem 14.4 on page 487 of your text. The number of moles for 100 g \(H_2O\) is given.

\(n_A = 5.55 \text{ mol } H_2O\)

\(n_B = _____ \text{ mol } \text{NaCl}\)

\[ X_{H_2O} = \quad \quad = _____ \]

\[ X_{NaCl} = \quad \quad = _____ \]

\[ X_{H_2O} + X_{NaCl} = 1.000 \]

_____ + _____ = 1.000

**Real-World Connection**

Describe how the mole fractions for a solution are similar to the pieces of a pie.
## Mixtures and Solutions

### Section 14.3 Factors Affecting Solvation

<table>
<thead>
<tr>
<th><strong>Main Idea</strong></th>
<th><strong>Details</strong></th>
</tr>
</thead>
</table>

**Skim** Section 3 of your text. List three main ideas of the section.

1. ________________________________
2. ________________________________
3. ________________________________

**New Vocabulary**

<table>
<thead>
<tr>
<th>Term</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>solvation</td>
<td></td>
</tr>
<tr>
<td>heat of solution</td>
<td></td>
</tr>
<tr>
<td>supersaturated solution</td>
<td></td>
</tr>
<tr>
<td>Henry's law</td>
<td></td>
</tr>
</tbody>
</table>

**Compare and contrast** saturated solutions and unsaturated solutions.
The Solvation Process
Use with pages 489–492.

Describe solutions by completing the following statements.
A solution may exist in gas, solid, or liquid form, depending on the state of its ______. Some combinations of substances easily form ______ and others do not. A substance that does not ______ in a solvent is ______ in that solvent.

Write the general rule to determine if solvation will occur.

List three factors that must be known about component substances to determine if solvation will occur.

1. _____________________________________________
2. _____________________________________________
3. _____________________________________________

Sequence the steps required for a sodium chloride crystal to dissolve in water.

___ The charged ends of water molecules attract the positive Na ions and the negative Cl ions.
___ The ions from the crystal break away from the surface.
___ Water molecules collide with the surface of the crystal.
___ NaCl crystals are placed in water.
___ Solvation continues until the entire crystal has dissolved.
___ The attraction between the dipoles and the ions are stronger than the attractions among the ions in the crystal.
Section 14.3 Factors Affecting Solvation (continued)

**Main Idea**

Factors That Affect Solvation

*Use with page 492.*

**Details**

Organize the following table on factors that can increase the rate of solvation by increasing the number of collisions.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Increase Collisions By</th>
</tr>
</thead>
<tbody>
<tr>
<td>agitating the mixture</td>
<td></td>
</tr>
<tr>
<td>breaking particles</td>
<td></td>
</tr>
<tr>
<td>into smaller pieces</td>
<td></td>
</tr>
<tr>
<td>increasing temperature</td>
<td></td>
</tr>
<tr>
<td>of the solvent</td>
<td></td>
</tr>
</tbody>
</table>

**Solubility**

*Use with pages 493–496.*

Explain how solubility is expressed in units of measurement.

Review Table 14.4 in your text to determine the solubility of the following compounds in water.

Ca(OH)\(_2\) at 20°C

KCl at 60°C

Describe each of these solubility states.

<table>
<thead>
<tr>
<th>State</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>continuing solvation</td>
<td></td>
</tr>
<tr>
<td>dynamic equilibrium</td>
<td></td>
</tr>
<tr>
<td>saturated solution</td>
<td></td>
</tr>
<tr>
<td>unsaturated solution</td>
<td></td>
</tr>
</tbody>
</table>
Section 14.3 Factors Affecting Solvation (continued)

Main Idea

Describe how solubility changes with temperature for most substances.

Explain why some gases are less soluble as temperature increases.

Describe the relationship between solubility and pressure.

Write the equation for Henry's law.

Henry’s Law

Use with Example Problem 14.5, page 497.

Summarize Fill in the blanks to help you take notes while you read Example Problem 14.5.

Problem

Find how much of a gas will dissolve in 1.0 L of water at 1.0 atm, if 0.85 g of that gas will dissolve in 1.0 L of water at 4.0 atm and temperature does not change.

1. Analyze the Problem

List the knowns and unknowns.

Known: Unknown:

$S_1$ = ______

$P_1$ = ______ $S_2$ = _____

$P_2$ = ______

2. Solve for the Unknown

Rearrange Henry’s Law to solve for $S_2$.

$S_2$ = ______

Substitute known values and solve.

$S_2 = ______ (1.0 \text{ atm}) = ______

3. Evaluate the Answer

The solubility ______ as expected due to the ______ in pressure.
Mixtures and Solutions
Section 14.4 Colligative Properties of Solutions

Scan Section 4 of your text, using 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 solutions.

Write two questions that you would want answers to based on your reading.
1. 
2. 

New Vocabulary

Use your text to define each term.
colligative property

vapor pressure lowering

boiling point elevation

freezing point depression

osmosis

osmotic pressure
Compare and contrast electrolytes and nonelectrolytes.
Substances like sodium chloride that _____ in water and conduct an ____________ are called _________. Substances like sucrose that dissolve in water but do not _____ and do not conduct an electric current are called ____________.

Summarize why vapor pressure lowering is a colligative property.
Include an explanation of vapor pressure.

Explain boiling point elevation by completing the following statements.
A liquid boils when its ____________ equals ______________.
Adding a nonvolatile solute lowers the solvent’s _____ pressure.
More _____ energy must be added to reach the solvent’s ____________. The greater the number of _____ particles in the solution, the greater the ____________ elevation.
Section 14.4 Colligative Properties of Solutions (continued)

**Main Idea**

**Freezing Point Depression**

*Use with pages 501–502.*

**Details**

Describe why the freezing point changes when a solute is added to a solution.

Evaluate the diagram of a semipermeable membrane separating a sucrose-water solution on one side and water on the other side. Draw an arrow to show in which direction more water will flow and circle the side which has the greater osmotic pressure.
Now that you have read the chapter, review what you have learned and write the key equations and relationships.

Use this checklist to help you study.

☐ Study your Science Notebook for this chapter.
☐ Study the definitions of vocabulary words.
☐ Review daily homework assignments.
☐ Reread the chapter and review 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.

Identify four ways in which an understanding of the properties of solutions and heterogenous mixtures can be applied to your own life.

1. 
2. 
3. 
4.
Define the following terms.

chemical equation

mole

Chapter 10
Describe the equation you would use to convert mass in grams to moles.

Chapter 12
Identify the three characteristics of particles about which the kinetic-molecular theory makes assumptions.

1.

2.

3.

Write the equation that represents the kinetic energy of a particle.
Energy and Chemical Change
Section 15.1 Energy

Main Idea

Details

Skim Section 1 of your text. Write two facts you discovered about energy.

1. ____________________________________________
   ____________________________________________

2. ____________________________________________
   ____________________________________________

New Vocabulary

Use your text to define each term.

energy

law of conservation of energy

calorie

joule

specific heat
Section 15.1 Energy (continued)

Main Idea ——— Details

The Nature of Energy

Use with pages 516–518.

Compare and contrast kinetic energy with potential energy.

On the curve below that represents the skier on a ski slope on page 516, label the place of greatest kinetic energy A, least kinetic energy B, greatest potential energy C, and least potential energy D.

Describe the skier above as a function of the law of conservation of energy.

Explain chemical potential energy.

Chemical ______ energy of a substance is a result of the arrangement of its _____ and the strength of the ___________ joining the atoms. During some ______ reactions, such as burning ___, much of the potential energy may be released as ____. Some of the energy may be converted to work, which is a form of _____ energy.

Specific Heat

Use with pages 519–520.

Identify each symbol in the equation for specific heat.

\[ q = c \times m \times \Delta T \]

____ represents heat absorbed or released
____ represents the specific heat of the substance
____ represents mass of a sample in grams
____ represents a change in temperature
Section 15.1 Energy (continued)

**Main Idea**

**Calculate Specific Heat**

*Use with Example Problem 15.2, page 521.*

**Details**

**Summarize.** Fill in the blanks to help you take notes while you read Example Problem 15.2.

**Problem**

The temperature of a sample of iron with a mass of 10.0 g changed from 50.4°C to 25.0°C with the release of 114 J heat. Determine the specific heat of iron.

1. **Analyze the Problem**
   - Known:
     - energy released =
     - \( \Delta T \) =
     - mass of iron =
   - Unknown:
     - specific heat of iron =

2. **Solve for the Unknown**
   - Write the equation for heat absorption.
     - \( q = \) __________
   - Solve for \( c \).
     - \( q = \)
     - \( c = \)

3. **Evaluate the Answer**
   - If the values used in the calculations have _____ significant figures, the answer must also have _____ significant figures. The calculated value matches the value for iron in Table 15.2.

**Real-World Connection**

Describe two potential problems with the use of the Sun as a source of everyday energy.

1. __________________________
2. __________________________
Energy and Chemical Change
Section 15.2 Heat

Main Idea

Details

Skim Section 2 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.

calorimeter

thermochemistry

system

surroundings

universe

enthalpy

enthalpy (heat) of reaction

Main Idea

Details

Skim Section 2 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.

calorimeter

thermochemistry

system

surroundings

universe

enthalpy

enthalpy (heat) of reaction
Section 15.2 Heat (continued)

**Main Idea**

**Calorimetry**
*Use with page 523.*

**Details**

Describe how a calorimeter measures heat.

Summarize. Fill in the blanks to help you take notes while you read Example Problem 15.3.

**Problem**

Determine the specific heat of a piece of metal with a mass of 4.68 g that absorbs 256 J of heat when its temperature increases by 182°C, and explain if the metal could be an [__________].

1. **Analyze the problem**
   *Known:* mass of metal = _____
   
   quantity of heat absorbed = _____
   
   _____ = 182°C

   *Unknown:* specific heat, \( c = ? \text{ J/(g \cdot °C)} \)

2. **Solve for the Unknown**

   Write the equation for absorption of heat.

   \( q = \) ______

   Solve for \( c \) by dividing both sides of the equation by \( m \times \Delta T \).

   \( c = \) _____
Chemical Energy and the Universe

Use with pages 525–528.

**Main Idea**

Substitute the known values into the equation.

\[ c = \text{__________} \]

Table 15.2 indicates the metal could be \( \text{__________} \).

**Details**

3. **Evaluate the Answer**

The quantities used in the calculation have _____ significant figures, and the answer is correctly stated with _____ significant figures. The calculation yielded the ________ unit, and the calculated __________ is the same as that for ________.

**Compare and contrast** *exothermic and endothermic reactions.*

**Write** the symbol for enthalpy (heat) of reaction.

**Explain** why chemists prefer to measure change in heat energy, rather than the total amount of heat energy present.
Energy and Chemical Change
Section 15.3 Thermochemical Equations

Main Idea

Skim Section 3. Focus on the subheadings, boldfaced words, and the main ideas. In the space below, summarize the main idea of this section.

New Vocabulary

thermochemical equation

enthalpy (heat) of combustion

molar enthalpy (heat) of vaporization

molar enthalpy (heat) of fusion

Use your text to define each term.

...
Section 15.3 Thermochemical Equations (continued)

Main Idea

Writing Thermochemical Equations
Use with page 529.

Details

Identify which of the reactions below is endothermic, and explain how you know.
1. $4\text{Fe}(s) + 3\text{O}_2(g) \rightarrow 2\text{Fe}_2\text{O}_3(s)$  \hspace{1cm} $\Delta H = -1625 \text{ kJ}$
2. $\text{NH}_4\text{NO}_3(s) \rightarrow \text{NH}_4^+(aq) + \text{NO}_3^-(aq)$  \hspace{1cm} $\Delta H = 27 \text{ kJ}$

Identify which of the reactions below is exothermic, and explain how you know.
1. $4\text{Fe}(s) + 3\text{O}_2(g) \rightarrow 2\text{Fe}_2\text{O}_3(s)$  \hspace{1cm} $\Delta H = -1625 \text{ kJ}$
2. $\text{NH}_4\text{NO}_3(s) \rightarrow \text{NH}_4^+(aq) + \text{NO}_3^-(aq)$  \hspace{1cm} $\Delta H = 27 \text{ kJ}$

Changes of State
Use with pages 530–531.

Name the common states of matter.
Section 15.3 Thermochemical Equations (continued)

Main Idea

Explain changes in physical states by completing the sentences below.

During vaporization, a _______ becomes a _______.
Energy must be _________ by the liquid.
During condensation, a _______ becomes a _______.
Energy is _________ by the gas.
During fusion of ice, a _______ becomes a _______.
Energy is _________ by the solid.

Details

Identify what the following equations represent.

\[ \Delta H_{vap} = -\Delta H_{cond} \]

\[ \Delta H_{fus} = -\Delta H_{solid} \]

Real-World Connection

Explain why a farmer would spray his orange trees with water when he knows the overnight temperature will be below 30°C.
Energy and Chemical Change
Section 15.4 Calculating Enthalpy Change

Main Idea

Scan Section 4 of your text. Use the checklist below to preview the section.

- 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 energy and chemical change.

Write three statements about calculating enthalpy change based on your reading.

1. 
2. 
3. 

New Vocabulary

Hess’s law

standard enthalpy (heat) of formation

Use your text to define each term.
Section 15.4 Calculating Enthalpy Change (continued)

Main Idea

Hess’s Law
Use with pages 534–536.

Describe Hess’s law by completing the following statement.

_________ is used to determine the __________ of a system by imagining that each reaction is part of a ____________, each of which has a known ΔH.

Examine Figure 15.13. Read the caption and follow the arrows. Then apply Hess’s law to fill in the blanks below.

ΔH for reaction c _______
ΔH for reaction d _______
sum of ΔH for reactions c and d _______

In other words, the ___________ for the conversion of S and O₂ to SO₃ is _______.

Explain standard enthalpy of elements and compounds by completing the following statements.

An element’s __________ is the normal ______ state at one __________ pressure and ______. For example, the standard state for iron is ____, for mercury is ____, and for oxygen is ____. Free elements such as these are assigned a ΔHᵢ°, or ___________ __________, of exactly ____. The ΔHᵢ° of many __________ has been measured __________. For example, the standard enthalpies of formation for the following compounds are:

NO₂(g) ____
SO₃(g) ____
SF₆(g) ____
Section 15.4 Calculating Enthalpy Change (continued)

Main Idea

The Summation Equation

Use with page 546.

Details

Write the formula that sums up the procedure for combining standard heats of formation equations to produce the desired equation and its \( \Delta H_{rxn}^0 \).

This equation says to _______ the ____ of heats of _______ of the _______ from the sum of the ____ of formation of the _______.

Summarize. Fill in the blanks to help you take notes as you work through Example Problem 15.6.

Problem

Calculate \( \Delta H_{rxn}^0 \) for the combustion of methane.

\[ \text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) \]

1. Analyze the Problem

Use the formula \( \Delta H_{rxn}^0 = \Sigma \Delta H_f^0 \text{(products)} - \Sigma \Delta H_f^0 \text{(reactants)} \) with data from Table R-11.

Known:

\[ \Delta H_f^0(\text{CO}_2) = \] 
\[ \Delta H_f^0(\text{H}_2\text{O}) = \] 
\[ \Delta H_f^0(\text{CH}_4) = \] 
\[ \Delta H_f^0(\text{O}_2) = \]

Unknown:

\[ \Delta H_{rxn}^0 = ? \text{ kJ} \]
Section 15.4 Calculating Enthalpy Change (continued)

2. Solve for the Unknown
   Use the formula \( \Delta H_{f\,x}^0 = \Sigma \Delta H_f^0 \) (products) \(-\Sigma \Delta H_f^0 \) (reactants)
   Substitute values in the formula
   \( \Delta H_{f\,x}^0 = \) ________________________________
   \( \Delta H_{f\,x}^0 = \) ____________________ = _______

3. Evaluate the Answer
   All values are _______ to the stated place. The calculated value matches that in Table R-11.

REAL-WORLD CONNECTION
Your family needs to choose a system to heat the new home you are building. From what you have learned so far, write down four questions you will use to evaluate the systems available.

1. ________________________________
2. ________________________________
3. ________________________________
4. ________________________________
Scan Section 5, using 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 energy and chemical change.

State the main concepts of this section.

Use your text to define each term.

spontaneous process

entropy

second law of thermodynamics

free energy

Define the following term.
demonstrate
Spontaneous Processes

Use with pages 542–545.

Compare and contrast spontaneous processes and non-spontaneous processes.

Identify the parts of the entropy equation.
\[ \Delta S_{\text{system}} = S_{\text{products}} - S_{\text{reactants}} \]
\( \Delta S \) represents ____________________________.
\( S \) represents ____________________________.

List five reactions or processes in which it is possible to predict change in entropy. For each process, indicate whether entropy will increase or decrease.

1. ____________________________
2. ____________________________
3. ____________________________
4. ____________________________
5. ____________________________
Write the equation for the standard free energy change under standard conditions.

Predict whether entropy increases or decreases for the reaction below and explain your reasoning.
\[ \text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g}) \]

Describe free energy changes by writing the word positive or negative in the appropriate blank.
If the sign of the free energy change is ________, the reaction is spontaneous.
If the sign of the free energy system is ________, the reaction is non-spontaneous.

Explain how \( \Delta H^0_{\text{system}} \) and \( \Delta S^0_{\text{system}} \) affect reaction spontaneity by completing the following table.

<table>
<thead>
<tr>
<th>How ( \Delta H^0_{\text{system}} ) and ( \Delta S^0_{\text{system}} ) Affect Reaction Spontaneity</th>
<th>( -\Delta H^0_{\text{system}} )</th>
<th>( +\Delta H^0_{\text{system}} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>+( \Delta S^0_{\text{system}} )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-( \Delta S^0_{\text{system}} )</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Now that you have read the chapter, review what you have learned and write three key equations or relationships.

1. 

2. 

3. 

Review

Use this checklist to help you study.

☐ Study your Science Notebook for this chapter.

☐ Study the definitions of vocabulary words.

☐ 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 Chapter Assessment at the end of the chapter.

REAL-WORLD CONNECTION

Explain why the energy that comes from chemical reactions is critical for almost every phase of your daily life.
## Reaction Rates

### Before You Read

**Review Vocabulary**  
Define the following terms.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boyle’s law</td>
<td></td>
</tr>
<tr>
<td>Charles’s law</td>
<td></td>
</tr>
<tr>
<td>Gay-Lussac’s law</td>
<td></td>
</tr>
<tr>
<td>molarity</td>
<td></td>
</tr>
</tbody>
</table>

**Chapter 9**  
Balance the following equation.

\[ \Box C_8H_{18}(l) + \Box O_2(g) \rightarrow \Box CO_2(g) + \Box H_2O(l) \]
Reaction Rates
Section 16.1 A Model for Reaction Rates

Main Idea

**Skim** Section 1 of your text. Preview headings, photos, captions, boldfaced words, problems, and graphs. Write three questions that come to mind.

1. 
2. 
3. 

New Vocabulary

*Use your text to define each term.*

**reaction rate**

**collision theory**

**activated complex**

**activation energy**

Academic Vocabulary

*Define the following term.*

**investigate**
Section 16.1 A Model for Reaction Rates (continued)

Expressing Reaction Rates

Use with page 560.

Calculate Average Reaction Rates

Use with Example Problem 16.1, page 562.

Main Idea

Expressing Reaction Rates

Use with page 560.

Details

Identify what each phrase or symbol represents in this equation.

Average rate = \( \frac{\Delta \text{quantity}}{\Delta t} \)

Average rate = the average is used because the rate changes over time

\( \Delta = \)________________________

\( t = \)________________________

Summarize Fill in the blanks to help you take notes while you read Example Problem 16.1.

Problem

Calculate the average reaction rate of the chemical reaction using the __________________ of butyl chloride in ____________.

1. Analyze the Problem

Known: Unknown:

________________________

[\( \text{C}_4\text{H}_9\text{Cl} \) at \( t_1 = 0.220M \)]

________________________

2. Solve for the Unknown

Write the equation.

Average reaction rate =

Insert known quantities.

Solve for the average rate =

\( 4.00 \text{ s} - 0.00 \text{ s} \)

= ______________________

Average reaction rate =

____________________

3. Evaluate the Answer

The answer is correctly expressed in ____ significant figures.
Section 16.1 A Model for Reaction Rates (continued)

**Main Idea**

**Collision Theory**

*Use with pages 563–564.*

**Details**

Describe how each of the items below affects a reaction.

- Collision theory
  
  orientation and the activated complex

- Activation energy and reaction

Analyze Figure 16.4. Use colored pencils to draw similar molecules colliding. Be sure to include incorrect orientation, correct orientation, and correct orientation with insufficient energy. Develop a key for your drawings.

Explain activation energy by completing the following paragraph.

Some reactions have enough ______ to overcome the _______ _______ of the reaction in order to form products. These are called _________________. After the _________________ is formed, _______ is released. In other reactions the reactants must absorb energy to overcome the _________________ of the reaction. These reactions are called _________________.

**Real-World Connection**

Describe how the collision theory would apply to a demolition derby.

---

224  A Model for Reaction Rates
Reaction Rates
Section 16.2 Factors Affecting Reaction Rates

Scan Section 2, using 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 this topic.

Write three facts you discovered about reaction rates.
1. 
2. 
3. 

Use your text to define each term.
catalyst

inhibitor

heterogeneous catalyst

homogeneous catalyst

The Nature of Reactants
Use with page 568.

Explain how reactants influence the rate at which a chemical reaction occurs by completing the following statement.

As the reactant increases, the ___________ increases.
Section 16.2 Factors Affecting Reaction Rates (continued)

Use with pages 568–573.

**Main Idea**

Compare and contrast the rate at which a sugar cube in cold water and granulated sugar in warm water would dissolve. Include how surface area and the temperature of the water might affect the rate at which each dissolves. Create a statement about which would dissolve faster.

**Details**

Explain the effect each of the following has on the rate of a reaction.

- Reactivity of reactants
- Concentration
- Surface area
- Temperature
- Catalyst
- Inhibitors

REAL-WORLD CONNECTION

Compare and contrast the rate at which a sugar cube in cold water and granulated sugar in warm water would dissolve. Include how surface area and the temperature of the water might affect the rate at which each dissolves. Create a statement about which would dissolve faster.
Reaction Rates
Section 16.3 Reaction Rate Laws

Main Idea

Details

**Skim** Section 3 of your text. Choose a photograph from this section. Write a question based on what you see and read.

---

**New Vocabulary**

Use your text to define each term.

- **rate law**
  - Definition
  - Details

- **specific rate constant**
  - Definition
  - Details

- **reaction order**
  - Definition
  - Details

- **method of initial rates**
  - Definition
  - Details
Section 16.3 Reaction Rate Laws (continued)

**Main Idea**

**Writing Reaction Rate Laws**

*Use with pages 574–576.*

**Details**

**Explain** what each symbol represents in the following equation.
Rate = \( k[A] \)

\( k = \) ______________

\( [A] = \) ______________

**Analyze** the rate law reaction for the decomposition of hydrogen peroxide.

\( 2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2 \)

rate law equation: rate = \( k[A] \), where \([A] = \) ______________

insert the reactant: rate = ______

**Express** the rate law reaction for this chemical reaction.

chemical equation: \( 2\text{NO(g)} + 2\text{H}_2(g) \rightarrow \text{N}_2(g) + 2\text{H}_2\text{O(g)} \)

rate law equation: rate = ______, where \([A] = \) represents the reactant ___ and \([B] = \) represents the reactant ___

insert the reactants: rate = ______

---

Reactions and Rates
Determining Reaction Order

Use with page 576.

Relate how the reaction rate varies with:

- concentration

the overall reaction order

Explain reaction order by completing the following sentences.

One of the means of determining reaction order is by comparing _______ of a reaction with varying ________________ .

This is known as the method of _________. This method requires experimentation with differing _______ of the reactants and comparing the _______ of the reaction at each quantity. While the rate law for a reaction can tell you the reaction rate, the rate constant $k$, and the ________________ , actual ______ and _____ of a complex reaction can be determined only through experimentation.

Real-World Connection

Consider whether an average of a student’s grades on all chemistry tests is or is not a better way of determining a final grade as compared to using just one test score. Explain which is better and why.
Reaction Rates
Section 16.4 Instantaneous Reaction Rates and Reaction Mechanisms

Main Idea

Skim Section 4 of your text. Preview the headings, photos, captions, boldfaced words, problems, and graphs. Write three questions that come to mind.

1. ______________________________________________________________________
2. ______________________________________________________________________
3. ______________________________________________________________________

New Vocabulary

Use your text to define each term.

*instantaneous rate*

*complex reaction*

*reaction mechanism*

*intermediate*

*rate-determining step*
Section 16.4 Instantaneous Reaction Rates and Reaction Mechanisms (continued)

**Main Idea**

Calculate Instantaneous Reaction Rates

*Use with Example Problem 16.2, page 579.*

**Details**

**Summarize** Fill in the blanks to help you take notes while you read Example Problem 16.2.

**Problem**

Calculate the instantaneous rate for this reaction, given the quantities for NO and H₂.

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

1. **Analyze the Problem**

   Known: Quantity of \([\text{NO}]\) = 0.00200 M
   
   Unknown: Rate = ? mol/(L \cdot s)
   
   Quantity of \([\text{H}_2]\) =_________
   
   \(k = \)_________

2. **Solve for the Unknown**

   Insert the known quantities into the rate law equation.

   \[ \text{rate} = \]_________
   
   \[ \text{rate} = \]_________
   
   \[ \text{rate} = \]_________

3. **Evaluate the Answer**

   Are your units correct? Is your magnitude reasonable?

**Compare** the reaction mechanism using the terms complex, intermediate, and rate-determining step to the process of building a car. Show that you understand the vocabulary.

---

**Reaction Mechanisms**

*Use with pages 580–582.*
Reaction Rates  Chapter Wrap-Up

Now that you have read the chapter, list three facts you learned about reaction rates:

1. 

2. 

3. 

Review

Use this checklist to help you study.

☐ Study your Science Notebook for this chapter.
☐ Study the definitions of vocabulary words.
☐ Review daily homework assignments.
☐ Reread the chapter and review the tables, graphs, and illustrations.
☐ Review the Section Assessment questions at the end of each section.
☐ Look over the Chapter Assessment at the end of the chapter.

Real-World Connection

Suppose you obtain a part-time job working for a lawn care business. Your new boss wants you to help her choose the right fertilizer for most of the lawns you will see. Use the terms from this chapter to explain to your boss what she should look for in a fertilizer.
Chemical Equilibrium

Before You Read

**Review Vocabulary**

Define the following terms.

*chemical equation*

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

*reaction rate*

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

*rate law*

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

Chapter 9

**Balance** the chemical equation below.

\[ \text{NO}(g) + \text{H}_2(g) \rightarrow \text{N}_2\text{O}(g) + \text{H}_2\text{O}(g) \]

Chapter 16

**Write** the rate law for the reaction below.

\[ \text{H}_2(g) + \text{I}_2(g) \rightarrow 2 \text{HI}(g) \]

Rate = ________________
Chemical Equilibrium
Section 17.1 A State of Dynamic Balance

Main Idea

Details

Skim Section 1 of your text. Write a statement that describes the nature of equilibrium from your reading of the headings, boldface terms, and illustration captions.

New Vocabulary

Use your text to define each term.

reversible reaction

chemical equilibrium

law of chemical equilibrium

equilibrium constant

homogeneous equilibrium

heterogeneous equilibrium
Section 17.1 A State of Dynamic Balance (continued)

**Main Idea**

**What is equilibrium?**

Use with pages 594–598.

**Details**

Explain reversible reactions by inserting the words left and right in the following statements.

The reactants for the forward reaction are on the _____ . The products are on the _____ . The reactants for the reverse reaction are on the _____ . The products are on the _____ .

List the reactants and products of the following reversible reaction.

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

<table>
<thead>
<tr>
<th>Reactants</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward reaction</td>
<td></td>
</tr>
<tr>
<td>Reverse reaction</td>
<td></td>
</tr>
</tbody>
</table>

Complete the following statement.

The state in which forward and reverse reactions balance each other because they take place at equal rates is called _______. Although a chemical reaction may be in equilibrium, the _____ and _____ may continually be _______ because chemical equilibrium is a dynamic process.

Identify the parts of the equilibrium constant expression.

\[ K_{eq} = \frac{[C]^c[D]^d}{[A]^a[B]^b} \]

\[ K_{eq} = \] ______________

\[ [C][D] = \] ______________

\[ [A][B] = \] ______________

\[ a, b, c, \text{and} \ d = \] ______________
Write the equilibrium constant expression for the following balanced chemical equation.

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

\[ K_{\text{eq}} = \text{________} \]

Compare and contrast homogeneous equilibrium and heterogeneous equilibrium by completing the following sentences.

Homogeneous equilibrium occurs when _______ and _______ of a reaction are in the _____ physical state. Heterogeneous equilibrium occurs when _______ and _______ of a reaction are in more than ___ physical state. Equilibrium depends on the ___________________ in the system.

Write the equilibrium expression for this reaction.

\[ \text{I}_2(\text{s}) \rightleftharpoons \text{I}_2(\text{g}) \]

Discuss why sodium hydrogen carbonate is valuable in baking.
Section 17.1 A State of Dynamic Balance (continued)

The Value of Equilibrium Constants

Use with Example Problem 17.3, page 605.

Summarize Fill in the blanks to help you take notes while you read Example Problem 17.3.

Problem

Calculate the value of \( K_{eq} \) for the equilibrium constant expression.

\[
K_{eq} = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3}
\]

1. Analyze the Problem
   List the knowns and unknowns.

   Known: the equilibrium constant expression:

   Known: the concentration of each reactant and product:

   \[ [\text{NH}_3] = \]  
   \[ [\text{N}_2] = \]  
   \[ [\text{H}_2] = \]

   Unknown: the value of the equilibrium constant

2. Solve for the Unknown
   Substitute the \( [\text{NH}_3] \) into the equilibrium expression and calculate its value.

   \[ K_{eq} = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3} = \]

3. Evaluate the Answer
   The given concentrations have _____ significant figures, therefore the answer must have _____ significant figures.
Chemical Equilibrium
Section 17.2 Factors Affecting Chemical Equilibrium

Scan Section 2 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 figures and read the captions.
• Think about what you already know about chemical equilibrium.

Write four facts you discovered about chemical equilibrium.
1. 
2. 
3. 
4. 

New Vocabulary
Le Châtelier’s principle

Use your text to define the following term.

Use your text to define the following term.
Section 17.2 Factors Affecting Chemical Equilibrium (continued)

**Applying Le Châtelier’s Principle**

*Use with pages 607–610.*

**Main Idea**

**Details**

Determine how each of the following changes affects a system in equilibrium. Write a sentence that includes the term(s) in parentheses.

- changes in concentration (collisions)

- changes in volume (pressure, products)

- changes in temperature (endothermic, exothermic)

**REAL-WORLD CONNECTION**

Describe how your body would relieve the stress placed on it by climbing to a high altitude.
Chemical Equilibrium
Section 17.3 Using Equilibrium Constants

Scan Section 3 of your text. Use the checklist below as a guide.
• Read all section heads.
• Read all boldfaced words.
• Read all the tables and graphs.
• Look at all pictures and read the captions.
• Think about what you already know about equilibrium constants.

Write three facts you discovered about using equilibrium constants.
1. ___________________________________________
2. ___________________________________________
3. ___________________________________________

New Vocabulary

solubility product constant
common ion
common ion effect

Use your text to define each term.
Section 17.3 Using Equilibrium Constants (continued)

Main Idea

Calculating Equilibrium Concentrations

Use with Example Problem 17.4, page 613.

Details

Summarize Fill in the blanks to help you take notes while you read example Problem 17.4.

Problem

At 1405 K, hydrogen sulfide ________ to form ________ and a diatomic ______ molecule, S2. The _________________ for the reaction is $2.27 \times 10^{-3}$.

$$2H_2S(g) \rightleftharpoons 2H_2(g) + S_2(g)$$

What is the concentration of H2(g) if $[S_2] = 0.0540$ mol/L and $[H_2S] = 0.184$ mol/L?

1. Analyze the Problem

List the knowns and unknowns.

Known: $K_{eq}$, $[S_2]$, $[H_2S]$ Unknown: $[H_2]$

2. Solve for the Unknown

Write the equilibrium constant expression.

$$K_{eq} =$$

Substitute known quantities.

Solve for the unknown.

3. Evaluate the Answer

The number of significant figures in the data is ______. Therefore, the number of significant figures in the answer must be ______.
Section 17.3 Using Equilibrium Constants (continued)

Main Idea

The Solubility Product Constant
Use with pages 614–619.

Details

Describe solubility equilibrium.

Identify the part of the equation that shows equilibrium and circle it.

\[ \text{BaSO}_4(s) \rightleftharpoons \text{Ba}^{2+}(aq) + \text{SO}_4^{2-}(aq) \]

Explain solubility by completing the following statements.

问题是 amount of a substance that will _______ in a given volume of ________.

\( K_{sp} \) represents the ________

\( K_{sp} \) is the _______ of the concentration ______ each raised to the power equal to the ______ of the ion in the ________.

\( K_{sp} \) depends only on the ________ of the _____ in a saturated ________.

Explain why it benefits doctors to understand solubility.

Calculating Molar Solubility
Use with Example Problem 17.5, page 616.

Problem

Calculate the solubility in mol/L of copper(II) carbonate (\( \text{CuCO}_3 \)) at 298 K.

1. Analyze the Problem

List the knowns and unknowns.

Known: \( K_{sp} \text{(CuCO}_3) = \) _______ solubility (\( \text{CuCO}_3 \)) = _______
Section 17.3 Using Equilibrium Constants (continued)

2. Solve for the Unknown
   Write the balanced chemical equation.

   Write the solubility constant expression (remember only the ions are used).

   \[ s = [\text{Cu}^{2+}] = \] 

   Substitute \( s \) for \([\text{Cu}^{2+}]\) and ____________________________

3. Evaluate the Answer
   \( K_{sp} \) has ___ significant figures so the answer must be expressed with ___ significant figures.

Describe conditions in which precipitates are likely to form.

1. ____________________________

2. ____________________________

3. ____________________________

The Common Ion Effect

Use with pages 620–621.

Discuss the common ion effect by completing the following paragraph.

An ion that is common to two or more ionic compounds is known as a __________. The lowering of the solubility of a substance by the presence of a common ion is called the ________________.
Chapter Wrap-Up

Now that you have read the chapter, review what you have learned.

Describe chemical equilibrium.

Explain Le Châtelier’s principle.

Review

Use this checklist to help you study.

☐ Study your Science Notebook for this chapter.
☐ Study the vocabulary words and scientific definitions.
☐ Review daily homework assignments.
☐ Reread the chapter and review 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

Describe several uses of solubility in your home.

[Additional content not shown]
Define the following term.

Write the equation for hydrogen chloride dissolving in water to form hydrogen ions and chloride ions.

Explain what type of compound hydrogen chloride is since it produces hydrogen ions in aqueous solution.

Identify five factors that influence reaction rate.

1. 

2. 

3. 

4. 

5. 
**Acids and Bases**  
*Section 18.1 Introduction to Acids and Bases*

**Main Idea**

**Details**

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

1. 

2. 

**New Vocabulary**

*Use your text to define each term.*

- **acidic solution**
  
- **basic solution**
  
- **Arrhenius model**
  
- **Brønsted-Lowry model**
  
- **conjugate acid**
  
- **conjugate base**
  
- **conjugate acid-base pair**
  
- **amphoteric**
  
- **Lewis model**
  
---

**Introduction to Acids and Bases**

246  

"Introduction to Acids and Bases"
Section 18.1 Introduction to Acids and Bases (continued)

**Main Idea**

Properties of Acids and Bases

Use with pages 634–636.

**Details**

Compare and contrast the properties of an acid and a base by placing an X in the Acid column if the property applies to an acid and in the Base column if the property applies to a base.

<table>
<thead>
<tr>
<th>Acid</th>
<th>Properties</th>
<th>Base</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>tastes sour</td>
<td></td>
</tr>
<tr>
<td></td>
<td>tastes bitter</td>
<td></td>
</tr>
<tr>
<td></td>
<td>feels slippery</td>
<td></td>
</tr>
<tr>
<td></td>
<td>affects color</td>
<td></td>
</tr>
<tr>
<td></td>
<td>reacts with metal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>conducts electricity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>has more hydrogen ions than hydroxide ions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>has more hydroxide ions than hydrogen ions</td>
<td></td>
</tr>
</tbody>
</table>

Write the chemical equation for the self-ionization of water.

Analyze why the Arrhenius model of acids and bases does NOT include ammonia (NH₃) in solution as a base.

Identify which of the following statements describes the Arrhenius model and which describes the Brønsted-Lowry model by filling in the blanks.

The ________ model is based on the dissociation of compounds, while the ____________ model is based on the donation and acceptance of hydrogen ions. Conjugate acid-base pairs are a component of the ____________ model and are NOT a component of the ________ model.
Section 18.1 Introduction to Acids and Bases (continued)

**Main Idea**

Describe what happens in the forward and reverse reactions when ammonia is dissolved in water. Identify the conjugate acid, the conjugate base, and the two conjugate acid-base pairs.

---

**Details**

Explain what a polyprotic acid is.

---

**Monoprotic and Polyprotic Acids**

Use with pages 640–641.

Sequence the following equations in the steps of the ionization of phosphoric acid in the correct order.

- HPO$_4^{2-}$(aq) + H$_2$O(l) $\rightarrow{\rightleftharpoons}$ H$_3$O$^+$aq) + PO$_4^{3-}$(aq)
- H$_3$PO$_4$(aq) + H$_2$O(l) $\rightarrow{\rightleftharpoons}$ H$_3$O$^+$aq) + H$_2$PO$_4^{2-}$(aq)
- H$_2$PO$_4$aq) + H$_2$O(l) $\rightarrow{\rightleftharpoons}$ H$_3$O$^+$aq) + HPO$_4^{2-}$(aq)

**The Lewis Model**

Use with pages 641–643.

Define and give examples of an anhydride, distinguishing between those that produce an acid and those that produce a base.

---
Skim Section 2 of your text. Focus on the headings, subheadings, boldfaced words, and the main ideas. Write three questions about strengths of acids and bases based on what you have read.

1. 

2. 

3. 

Use your text to define each term.

strong acid

weak acid

acid ionization constant

strong base

weak base

base ionization constant
Section 18.2 Strengths of Acids and Bases (continued)

Main Idea

Strengths of Acids

Use with pages 644–647.

Details

Explain why all acids are not equal in strength.

Identify the acids in the following table as strong or weak.

<table>
<thead>
<tr>
<th>Acid</th>
<th>Strong or Weak</th>
<th>Acid</th>
<th>Strong or Weak</th>
</tr>
</thead>
<tbody>
<tr>
<td>acetic</td>
<td>Strong</td>
<td>hydroiodic</td>
<td>Weak</td>
</tr>
<tr>
<td>carbonic</td>
<td>Strong</td>
<td>hydrosulfuric</td>
<td>Weak</td>
</tr>
<tr>
<td>hydrochloric</td>
<td>Strong</td>
<td>nitric</td>
<td>Weak</td>
</tr>
<tr>
<td>hydrofluoric</td>
<td>Strong</td>
<td>sulfuric</td>
<td>Weak</td>
</tr>
</tbody>
</table>

Describe the difference in conductivity between strong and weak acids.

Analyze equilibrium constant expressions by completing the following statements.

The concentration of liquid water in the denominator of an equilibrium constant expression is considered to be ________ in dilute aqueous solutions. Therefore, liquid water can be ________ $K_{eq}$ to give a new equilibrium constant, $K_a$. For weak acids, the equilibrium ________ of the ________ in the numerator tends to be small compared to the equilibrium ________ of the ________ in the denominator. The weakest acids have the ________ $K_a$ values because their solutions have the highest concentrations of ________ acid molecules.
Compare and contrast the strengths of acids and bases by completing this concept map using the terms ionize, ionization constant, strong, stronger, weak, and weaker.

**Main Idea**

**Details**

**Strengths of Bases**
Use with pages 648 and 649.

Describe the differences between the strength and the concentration of acids and bases by completing the following statements.

The number of the acid or base molecules dissolved is described by the terms _____ and __________. The degree to which an acid or base separates into ions is described by the terms _____ and _____.

A strong acid can be a _____ solution and a _____ acid can be a concentrated solution.
Acids and Bases
Section 18.3 Hydrogen Ions and pH

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

- Read all section titles.
- Read all boldfaced words.
- Read all formulas.
- Look at all figures and read the captions.
- Think about what you already know about alcohols, ethers, and amines.

Write three facts you discovered about pH as you scanned the section.

1. ____________________________________________________________
2. ____________________________________________________________
3. ____________________________________________________________

New Vocabulary

Use your text to define the following terms.

- ion product constant for water
  __________________________________________________________________
  __________________________________________________________________

- pH
  __________________________________________________________________

- pOH
  __________________________________________________________________
Section 18.3 Hydrogen Ions and pH (continued)

**Main Idea**

Ion Product Constant for Water

Use with pages 650–651.

**Details**

**Describe** how the ion product constant for water is derived from the self-ionization equation.

\[
\text{H}_2\text{O}(l) \rightleftharpoons \text{H}^+ + \text{OH}^- \\
K_{\text{eq}} = \frac{[\text{H}^+][\text{OH}^-]}{[\text{H}_2\text{O}]} = K_w \\
K_w = [\text{H}^+][\text{OH}^-] = \text{const.}
\]

**Summarize** Fill in the blanks to help you take notes while you read Example Problem 18.1.

**Problem**

Calculate \([\text{OH}^-]\) using \([\text{H}^+]\) and the concentration of \(\text{H}_2\text{O}\), and determine if the solution is acidic, basic, or neutral.

**Step 1: Analyze the Problem**

Known: \([\text{H}^+]\) = \(\text{mol/L}\)  \(\text{K}_w\)  
Unknown: \([\text{OH}^-]\) = \(\text{mol/L}\)

Write what you can predict about \([\text{OH}^-]\):

**Step 2: Solve for the Unknown**

Write the ion product constant expression

\(K_w = \text{const.}\)

Solve for \([\text{OH}^-]\) by \(\text{expression}\).

\([\text{OH}^-] = \text{mol/L}\)

\([\text{OH}^-] = \text{mol/L}\)

Since \([\text{H}^+] > [\text{OH}^-], \text{solution is acidic}.\)
Section 18.3 Hydrogen Ions and pH (continued)

**Main Idea**

**Details**

Step 3: Evaluate the Answer

The answer is correctly stated with ____ significant figures because [H⁺] and [OH⁻] each have two. The hydroxide ion concentration ______ the prediction.

Compare and contrast pH and pOH by completing the following table.

<table>
<thead>
<tr>
<th>Solution Type</th>
<th>Scale Measure</th>
<th>Relationship (Equation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>acid</td>
<td>pH</td>
<td></td>
</tr>
<tr>
<td>base</td>
<td></td>
<td></td>
</tr>
<tr>
<td>acid and base</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Analyze the process of calculating pH and pOH from the hydroxide concentration.

________________________________________________________

________________________________________________________

________________________________________________________

Describe the process of calculating the hydrogen ion and hydroxide ion concentrations from pH.

________________________________________________________

________________________________________________________

________________________________________________________

Describe the process of calculating $K_a$ from pH for a 0.100M weak acid.

________________________________________________________

________________________________________________________

________________________________________________________

________________________________________________________
Acids and Bases

Section 18.4 Neutralization

Main Idea

Skim Section 4 of your text. Focus on the headings, subheadings, boldfaced words, and the main ideas. Write three questions about strengths of acids and bases based on what you have read.

1. 
2. 
3. 

Details

Define the following terms.

neutralization reaction

salt

titration

titrant

equivalence point

acid-base indicator

end point

salt hydrolysis

buffer

buffer capacity
Write the full equation of the neutralization reaction for magnesium hydroxide and hydrochloric acid.

Draw the titration curve for 50.0 mL 0.100M HCl titrated with 0.100M NaOH. Label the pH and volume vectors, as well as the equivalence point.

Describe the indicator that matches each of the following pH levels. Use Figure 18.24 as a guide.

<table>
<thead>
<tr>
<th>pH</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.2</td>
<td></td>
</tr>
<tr>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>1–12</td>
<td></td>
</tr>
</tbody>
</table>

Explain the process for calculating the molarity of an unknown HCOOH solution by completing the equations below. Balanced equation:

HCOOH(aq) + NaOH(aq) → HCOONa(aq) + H₂O(l)

18.28 mL NaOH × _____________________ = _______ L NaOH

0.01828 L NaOH × _____________________

= _______ mol NaOH

1.828 × 10⁻³ mol NaOH × _____________________

= _______ mol HCOOH

1.828 × 10⁻³ mol HCOOH / _____________________

= _______ M HCOOH
Salt Hydrolysis

Use with page 665.

Describe salt hydrolysis by completing the following statements.

Some aqueous salt solutions are neutral, some are basic, and some are basic. The reason for this is a process known as hydrolysis. In this process, the anions of the dissociated salt donate protons to water. Salts that will hydrolyze have a weak acid and a weak base or a strong acid and a strong base. A salt formed from a strong acid and a weak base will form an acid. A salt formed from a strong base and a weak acid will form a base. Salts formed from weak acids and bases or from strong acids and bases will not hydrolyze and form a neutral solution.

Buffered Solutions

Use with pages 666–667.

Explain how a buffer works by completing the table below.

<table>
<thead>
<tr>
<th>The equation at equilibrium</th>
<th>HF(aq) ⇌ H⁺(aq) + F⁻(aq)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δ Condition</td>
<td>Equilibrium Shift</td>
</tr>
<tr>
<td>add acid</td>
<td>left</td>
</tr>
<tr>
<td>add base</td>
<td>right</td>
</tr>
</tbody>
</table>

A greater number of the buffering molecules and ions in the solution leads to a decrease in the ionization of the solution. A buffer has a weak acid or a base with its conjugate base or acid.
Now that you have read the chapter, review what you have learned; write out three key equations and relationships.

1. ____________________________________________

2. ____________________________________________

3. ____________________________________________

Review

Use this checklist to help you study.

☐ Study your Science Notebook for this chapter.
☐ Study the definitions of vocabulary words.
☐ Review daily homework assignments.
☐ Reread the chapter and review 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

Suppose you are on the bench for your school’s soccer team when one of the players comes out of the game with a cramp. A teammate suggests that she start breathing into a paper bag to recover sooner. Explain whether or not this is good advice.

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________
Redox Reactions

Before You Read

Review Vocabulary

Define the following terms.

**electronegativity**

______________________________________________________________________________

______________________________________________________________________________

**chemical reactions**

______________________________________________________________________________

______________________________________________________________________________

Chapter 7

Compare and contrast monatomic ions and polyatomic ions.

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

Chapter 9

List five types of chemical reactions.

1. _______________________________________________________________________

2. _______________________________________________________________________

3. _______________________________________________________________________

4. _______________________________________________________________________

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

1. ______________________________________________________________________
2. ______________________________________________________________________
3. ______________________________________________________________________

Use your text to define each term.

- oxidation-reduction reaction
- redox reaction
- oxidation
- reduction
- oxidizing agent
- reducing agent

Describe redox reactions by completing the statement below. Use Figure 19.1 in your text as reference.

A redox reaction consists of two complimentary processes. Oxidation results in a ______________ and an increased ______________. Reduction results in a ______________ and a ______________ oxidation number.
Section 19.1 Oxidation and Reduction (continued)

**Main Idea**

Oxidizing and Reducing Agents

*Use with page 683.*

**Details**

Compare and contrast *an oxidizing agent and a reducing agent.*

---

**Identify Oxidation–Reduction Reactions**

*Use with Example Problem 19.1, page 685.*

**Problem**

Write the equation for the redox reaction:

Identify what is ________ and what is ________ in the redox reaction of aluminum and iron. Identify the ________________ and the ________________.

1. **Analyze the Problem**
   Known: ________________________________
   Unknown: ________________________________

2. **Solve for the Unknown**
   Al becomes Al$^{3+}$ and ____________ electrons.
   Fe$^{3+}$ becomes Fe and gains _______ electrons.

3. **Evaluate the Answer**
   Aluminum ____________ electrons and is ____________.
   It is the ____________ agent. Iron ________________
   electrons and is ____________. It is the ____________ agent.
Determining Oxidation Numbers

Use with page 686.

Describe the rules for determining oxidation numbers by completing these statements.

1. The oxidation number of an uncombined atom is ____________.  
2. The oxidation number of a monatomic ion is equal to _____________.  
3. The oxidation number of the more electronegative atom in a molecule or a complex ion is the same as _____________.  
4. The oxidation number of fluorine, the most electronegative element, when it is bonded to another element is ___.  
5. The oxidation number of oxygen in compounds is ___, except in peroxides where it is ___. The oxidation number of oxygen when it bonds to fluorine is ____________.  
6. The oxidation number of hydrogen in most of its compounds is ___.  
7. The oxidation numbers of the metal atom in the compounds formed by the metals of groups 1 and 2 and aluminum in group 13 are _____________. respectively. These oxidation numbers are equal to _____________.  
8. The sum of the oxidation numbers in a neutral compound is ____________.  
9. The sum of the oxidation numbers of the atoms in a polyatomic ion is equal to _____________.

Describe the redox reaction for the equation listed below. Use the example on page 688 of your text to complete the table, then label the oxidation numbers of the elements in the equation and indicate the change in each.

\[ 2Al + Fe_2O_3 \rightarrow 2Fe + Al_2O_3 \]
Redox Reactions
Section 19.2 Balancing Redox Equations

Main Idea

Details

Scan Section 2 of your text, using the checklist below as a guide.
• Read all section titles.
• Read all boldfaced words.
• Read all formulas.
• Look at all figures and read the captions.
• Think about what you already know about redox reactions.

Write three facts you discovered about balancing redox reactions.
1. 
2. 
3. 

New Vocabulary

oxidation-number method

species

half-reaction

Use your text to define this term.

The Oxidation-Number Method

Use with page 689.

Sequence the steps for balancing redox reactions by the oxidation-number method.

____ Identify the atoms that are oxidized and the atoms that are reduced.
____ Assign oxidation numbers to all atoms in the equation.
____ Make the change in oxidation numbers equal in magnitude by adjusting coefficients in the equation.
____ If necessary, use the conventional method to balance the remainder of the equation.
____ Determine the change in oxidation number for the atoms that are oxidized and for the atoms that are reduced.
Section 19.2 Balancing Redox Equations (continued)

Main Idea

The Oxidation-Number Method

Use with Example Problem 19.3, page 690.

Details

Summarize Fill in the blanks to help you take notes while you read Example Problem 19.3.

Problem Balance the ______ equation for the _______ that produces _________.

\[ \text{Cu} + \text{HNO}_3 \rightarrow \text{Cu(NO}_3)_2 + \text{NO}_2 + \text{H}_2 \text{O} \]

1. Analyze the Problem
   Known:
   The formulas for the reactants and _______; the rules for determining ______________; and the fact that the increase in the oxidation number of the ______________ must equal the ______________ of the reduced atoms.
   Unknown:

2. Solve for the Unknown
   Step 1 Assign oxidation numbers to all the atoms in the equation.

\[
\text{Cu} + \text{HNO}_3 \rightarrow \text{Cu(NO}_3)_2 + \text{NO}_2 + \text{H}_2 \text{O}
\]

   Step 2 Identify which atoms are oxidized (using black arrows) and which are reduced (using red arrows).

\[
\text{Cu} + \text{HNO}_3 \rightarrow \text{Cu(NO}_3)_2 + \text{NO}_2 + \text{H}_2 \text{O}
\]

   Step 3 Determine the change in oxidation number for the atoms that are oxidized and for the atoms that are reduced. Complete the following tables.

\[
\text{Cu} + \text{HNO}_3 \rightarrow \text{Cu(NO}_3)_2 + \text{NO}_2 + \text{H}_2 \text{O}
\]

   Step 4 To make the net changes in oxidation number have the same magnitude, \text{HNO}_3 on the left and \text{NO}_2 on the right must be multiplied by _____.

264  Balancing Redox Equations
Main Idea

Step 5 Increase the coefficient of HNO₃ from 2 to ____ to balance the nitrogen atoms in the products. Add a coefficient of ____ to H₂O to balance the number of hydrogen atoms on the left.

3. Evaluate the Answer

The number of atoms of each element is _____ on both sides of the equation. No subscripts have been ______.

Details

Describe how the form of the balanced equation for the oxidation of copper by nitric acid, below:

\[
\text{Cu(s)} + 4\text{HNO}_3(\text{aq}) \rightarrow \text{Cu(NO}_3)_2(\text{aq}) + 2\text{NO}_2(\text{g}) + 2\text{H}_2\text{O(l)}
\]

is changed when rewritten as:

\[
\text{Cu(s)} + 4\text{H}^+(\text{aq}) + 4\text{NO}_3^-(\text{aq}) \rightarrow \text{Cu}^{2+}(\text{aq}) + 2\text{NO}_3^-(\text{aq}) + 2\text{NO}_2(\text{g}) + 2\text{H}_2\text{O(l)}
\]

Solve Read Example Problem 19.4 in your text.

You Try It

• Problem

Balance the net ionic redox equation for the reaction between the perchlorate ion and the iodide ion in acid solution.

\[
\text{ClO}_3^-(\text{aq}) + \text{I}^-(\text{aq}) \rightarrow \text{Cl}^-(\text{aq}) + \text{I}_2(\text{s}) \text{ (in acid solution)}
\]

1. Analyze the Problem

Known: __________________________________________

_____________________________________

Unknown: _______________________________________

Balance a Net Ionic Redox Equation

Use with Example Problem 19.4, page 692.

Balancing Net Ionic Redox Equations

Use with page 691.
2. Solve for the Unknown

Step 1 Assign oxidation numbers to all the atoms in the equation.

\[ \text{ClO}_3^-(aq) + I^-(aq) \rightarrow \text{Cl}^-(aq) + I_2(s) \text{ (in acid solution)} \]

Step 2 Identify which atoms are oxidized (using black arrows) and which are reduced (using red arrows).

\[ \text{ClO}_3^-(aq) + I^-(aq) \rightarrow \text{Cl}^-(aq) + I_2(s) \text{ (in acid solution)} \]

↑

Step 3 Determine the change in oxidation number for the atoms that are oxidized and for the atoms that are reduced. Complete the following tables.

\[ \text{ClO}_3^-(aq) + 6I^-(aq) \rightarrow \text{Cl}^-(aq) + 3I_2(s) \text{ (in acid solution)} \]

Step 4 To make the net changes in oxidation number have the same magnitude, place the appropriate coefficients in front of the formulas in the equation.

\[ \text{ClO}_3^-(aq) + 6I^-(aq) \rightarrow 3\text{Cl}^-(aq) + 3I_2(s) \text{ (in acid solution)} \]

Step 5 Write an equation that adds enough hydrogen ions and water molecules to balance the oxygen atoms on both sides.

3. Evaluate the Answer

The number of atoms of each element is _____ on both sides of the equation. The net charge on the right _____ the net charge on the left. No subscripts have been ______.
### Main Idea

Balancing Redox Equations Using Half-Reactions

*Use with pages 693–694.*

### Details

**Identify** the number of species in each reaction. Then, show the oxidation half-reaction and the reduction half-reaction for each equation.

<table>
<thead>
<tr>
<th>Reaction</th>
<th>No. of Species</th>
<th>Half-Reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Oxidation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduction</td>
</tr>
<tr>
<td>$4Fe + 3O_2 \rightarrow 2Fe_2O_3$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$4Fe + 3Cl_2 \rightarrow 2Fe_2Cl_3$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Sequence** the steps for balancing by half-reactions.

1. Adjust the coefficients so that the number of electrons lost in oxidation equals the number of electrons gained in reduction.
2. Write the net ionic equation for the reaction, omitting spectator ions.
3. Add the balanced half-reactions and return spectator ions.
4. Write the oxidation and reduction half-reactions for the net ionic equation.
5. Balance the atoms and charges in each half-reaction.
Section 19.2 Balancing Redox Reactions (continued)

**Main Idea**

**Balance a Redox Equation by Using Half-Reactions**

*Use with Example Problem 19.5, page 695.*

**Details**

**Summarize** Fill in the blanks to help you take notes while you read Example Problem 19.5.

**Problem**

Balance the redox equation for the _______ of permanganate and sulfur dioxide when sulfur dioxide ____ is bubbled into an ____ solution of ________________.

\[ \text{KMnO}_4(\text{aq}) + \text{SO}_2(\text{g}) \rightarrow \text{MnSO}_4(\text{aq}) + \text{K}_2\text{SO}_4(\text{aq}) \]

1. **Analyze the problem**
   
   Known:
   
   __________________________
   
   __________________________
   
   Unknown:
   
   __________________________
   
   __________________________

2. **Solve for the Unknown**
   
   **Step 1:** Write the net ionic equation for the reaction:
   
   __________________________
   
   **Step 2:** Using rule number 5, the oxidation number for Mn in \( \text{MnO}_4^- \) is _____. Using rule number 2, the oxidation number for \( \text{Mn}^{2+} \) is _____. The reduction half-reaction is ____________________.
   
   **Step 3(a):** Balance the atoms and charges in the half-reaction.
   
   __________________________
Step 3(b): The ____ ions are readily available and can be used to balance the charge in half-reactions in acid solutions. The number of H+ ions added to the right side of the oxidation half-reaction is _____. The number of H+ ions added to the left side of the reduction half-reaction is _____.

Write the oxidation half-reaction: ________________________.
Write the reduction half-reaction: ________________________.

Step 4: The number of electrons lost in oxidation is ____. The number of electrons gained in reduction is ____. The least common multiple of these numbers is ____. To balance the half-reactions, the atoms in the oxidation half-reaction must be multiplied by ____ and the atoms in the reduction half-reaction must be multiplied by _____. The oxidation half-reaction is now

______________________________

The reduction half-reaction is now

______________________________

Step 5: After adding the balanced half-reactions, write the redox reaction equation:

______________________________

Cancel or reduce like terms on both sides of the equation, then write the simplified equation:

______________________________

Return spectator ions ____ and restore the state descriptions.

3. Evaluate the Answer

The number of _____ for each element is _____ on both sides of the equation and none of the subscripts have been changed.
Redox Reactions  Chapter Wrap-Up

After reading this chapter, summarize the processes that occur in a redox reaction.

---

Use this checklist to help you study.

☐ Study your Science Notebook for this chapter.
☐ Study the definitions of vocabulary words.
☐ Review daily homework assignments.
☐ Reread the chapter and review 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

Photosynthesis is an example of a series of naturally occurring redox reactions. In this context, discuss the importance of redox reactions to life on Earth.
Electrochemistry

Before You Read

<table>
<thead>
<tr>
<th>Review Vocabulary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Define the following terms.</td>
</tr>
</tbody>
</table>

- energy
- chemical potential energy
- spontaneous process
- oxidation
- reduction
- half-reaction

Chapter 9

Identify three types of reactions.

1. 
2. 
3. 

Organize the following elements from least active to most active. Refer to the activity series in Figure 9.13.

aluminum, copper, calcium, gold, rubidium, iron, lead, potassium
Electrochemistry
Section 20.1 Voltaic Cells

Main Idea

Skim Section 1 of your text. Focus on the headings, subheadings, boldfaced words, and the main ideas. Summarize three main ideas of this section.

1. 

2. 

3. 

New Vocabulary

Use your text to define each term.

- salt bridge
- electrochemical cell
- voltaic cell
- half-cell
- anode
- cathode
- reduction potential
- standard hydrogen electrode

Academic Vocabulary

Define the following term.

- correspond
Redox in Electrochemistry

Use with pages 708–709.

Chemistry of Voltaic Cells

Use with page 710.

**Main Idea**

**Details**

**Explain** the branch of chemistry called electrochemistry.

**Write** the half-reactions of copper and zinc.

- (reduction half-reaction: electrons ___)
- (oxidation half-reaction: electrons ___)

**Explain** how an electrochemical cell uses a redox reaction.

**Complete** each of the following statements.

1. The electrode where oxidation takes place is called the _____.
2. The electrode where reduction takes place is called the _____.
3. An object’s potential energy is _________________________.
4. In electrochemistry, ________________________ is a measure of the amount of _____ that can be generated from a _______ to do work.

**Sequence** the steps of the electrochemical process that occur in a zinc-copper voltaic cell. The first one has been done for you.

1. To complete the circuit, both positive and negative ions move through the salt bridge. The two half-reactions can be summed to show the overall cell reaction.

2. The electrons flow from the zinc strip and pass through the external circuit to the copper strip.

1. Electrons are produced in the oxidation half-cell according to this half-reaction: Zn(s) → Zn^{2+}(aq) + 2e^{-}.

2. Electrons enter the reduction half-cell where the following half-reaction occurs: Cu^{2+} (aq) + 2e^{-} → Cu(s).
Section 20.1 Voltaic Cells (continued)

Main Idea

Calculating Electrochemical Cell Potential

Use with pages 711–712.

Details

Describe reduction potential in relation to an electrode.

Analyze Table 20.1. Some of the $E^0$ (V)s are positive, some are negative. Explain the difference.

Write the abbreviated $E^0$ and half-reaction for each of the following:

<table>
<thead>
<tr>
<th>Element</th>
<th>Half-Reaction</th>
<th>$E^0$ (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Li</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Au</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PbSO₄</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Na</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Summarize Fill the blanks to help you take notes while you read Example Problem 20.1.

Problem

Calculate the overall cell reaction and the standard potential for the half-cells of a voltaic cell.

\[ \text{I}_2(s) + 2e^- \rightarrow 2\text{I}^-(aq) \]

\[ \text{Fe}^{2+}(aq) + 2e^- \rightarrow \text{Fe} (s) \]

1. Analyze the Problem.

   List the known and the unknown.

   Known: Standard reduction potentials for the half-cells

   Unknown: 
Section 20.1 Voltaic Cells (continued)

**Main Idea**

2. Solve for the unknown.
   Find the standard reduction potentials for half-reactions.
   \[ E_{I_2|I^-}^0 = \]  
   \[ E_{Fe^{2+}|Fe}^0 = \]
   Rewrite the half-reactions in the correct direction.
   reduction half-cell reaction: ________________________________
   oxidation half-cell reaction: ________________________________
   overall cell reaction: _______ I_2(s) + Fe(s) → Fe^{2+}(aq) + 2I^-(aq)
   Balance the reaction if necessary:

   Calculate cell standard potential:
   \[ E_{cell}^0 = E_{reduction}^0 - E_{oxidation}^0 \]
   \[ E_{cell}^0 = +0.536 \text{ V} - \]  
   \[ E_{cell}^0 = + \]  
   Write the reaction using cell notation:

**Details**

3. Evaluate the answer.
   The answer seems reasonable given the ____________
   of the ___________ that comprise it.

**Using Standard Reduction Potentials**

*Use with page 716.*

**Write** the steps for the process of predicting whether any proposed redox reaction will occur spontaneously.

1. ______________________________________
2. ______________________________________
3. ______________________________________
4. ______________________________________
5. ______________________________________
Electrochemistry
Section 20.2 Batteries

Main Idea

**Skim** Section 2 of your text. Write three questions that come to mind after reading the headings and the illustration captions.

1. ____________________________________________

2. ____________________________________________

3. ____________________________________________

Details

Use your text to define each term.

**battery** ____________________________________________

**dry cell** ____________________________________________

**primary battery** ____________________________________________

**secondary battery** ____________________________________________

**fuel cell** ____________________________________________

**corrosion** ____________________________________________

**galvanization** ____________________________________________

New Vocabulary
Dry Cells

Use with pages 718–720.

Write the oxidation half-reaction for the dry cell of the most commonly used voltaic cell.

List the paste and cathode type for each of the following batteries. So-called dry cell batteries contain different moist pastes in which the cathode half-reaction takes place.

Zinc-carbon battery
Paste
Cathode type
Alkaline battery
Paste
Cathode type
Mercury battery
Paste
Cathode type

Compare and contrast primary and secondary batteries.

Explain how NiCad batteries, often found in cordless tools and phones, are recharged.
Section 20.2 Batteries (continued)

**Main Idea**

**Lead-Acid Storage Battery**
*Use with pages 720–721.*

**Details**

Explain how the following overall reaction of lead-acid batteries is different from traditional redox reactions.

\[
Pb(s) + PbO_2(s) + 4H^+(aq) + 2SO_4^{2-}(aq) \rightarrow 2PbSO_4(s) + 2H_2O(l)
\]

**Lithium Batteries**
*Use with pages 721–722.*

List two reasons that scientists and engineers have focused a lot of attention on the element lithium to make batteries.

1. 

2. 

**Fuel Cells**
*Use with pages 722–723.*

Describe two applications of lightweight lithium batteries.

**Details**

Explain the makeup of a fuel cell by completing the following paragraph and accompanying reactions.

In a fuel cell, each electrode that allows contact between the \___\____\___\____\_. The walls of the chamber also contain \___\___\___\___\___\_, such as powdered platinum or palladium, which \___\___\___\___\_.

oxidation half-reaction: 

reduction half-reaction: 

overall cell reaction: 

The overall cell reaction is the same as the equation for the \___\___\___\___\_.

List three reasons why PEMs are used instead of a liquid electrode.

1. 

2. 

3. 
**Corrosion**

*Use with pages 724–727.*

**Main Idea**

**Details**

**Compare** rusting of metal to redox reactions in voltaic cells.

**Draw** and label the parts of the corrosion reaction in Figure 20.15.

Be sure to identify the anode and cathode.

**Explain** why rusting is a slow process. List a way that it might be sped up in certain areas.

**Explain** the two ways galvanizing helps prevent corrosion.

1. 
2. 
Scan Section 3 of your text. Use the checklist below as a guide.
- Read all section titles.
- Read all boldfaced words.
- Read all formulas.
- Look at all figures and read the captions.
- Think about what you already know about electrolysis.

Write three facts you discovered about electrolysis as you scanned the section.

1. 
2. 
3. 

Use your text to define each term.

electrolysis

electrolytic cell
## Section 20.3 Electrolysis (continued)

### Main Idea

**Reversing Redox Reactions**

*Use with page 728.*

**Applications of Electrolysis**

*Use with pages 729–732.*

### Details

**Describe** how it is possible to reverse a spontaneous redox reaction in an electrochemical cell.

**Compare** the reactions involved in sodium chloride to those in the electrolysis of brine.

**Explain** the importance of electrolysis in the purification of metals.
Electrochemistry Chapter Wrap-Up

After reading this chapter, list three important facts you have learned about electrochemistry.

1. 

2. 

3. 

Use this checklist to help you study.

☐ Study your Science Notebook for this chapter.

☐ Study the definitions of vocabulary words.

☐ Review daily homework assignments.

☐ Reread the chapter and review 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

Describe how electrochemistry is involved in producing energy in batteries.
# Hydrocarbons

## Before You Read

<table>
<thead>
<tr>
<th>Review Vocabulary</th>
<th>Define each term.</th>
</tr>
</thead>
<tbody>
<tr>
<td>covalent bond</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Lewis structure   |                   |
|                   |                   |

**Chapter 8**

Draw the Lewis structure for $NH_3$.

<table>
<thead>
<tr>
<th>Chapter 12</th>
<th>Compare and contrast melting and boiling.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Hydrocarbons
Section 21.1 Introduction to Hydrocarbons

Main Idea

Scan Section 1 of your text. Use the checklist below as a guide.
- Read all section titles.
- Read all boldfaced words.
- Look at all pictures and read the captions
- Think about what you already know about this subject.

Write three facts you discovered about hydrocarbons.

1. ____________________________________________

2. ____________________________________________

3. ____________________________________________

New Vocabulary

Use your text to define each term.

organic compound

hydrocarbon

saturated hydrocarbon

unsaturated hydrocarbon

fractional distillation

cracking
**Main Idea**

Organic Compounds

*Use with pages 744–745.*

**Details**

**Explain the evolution of the contemporary understanding of the term organic compound.**

In the early nineteenth century, chemists referred to the variety of carbon compounds produced by living things as organic compounds.

Today the term organic compound is applied to all carbon-containing compounds with the primary exceptions of carbon oxides, carbides, and carbonates, which are considered inorganic.

**Explain why many compounds contain carbon by completing the following statements.**

Carbon’s __________________ allows it to make four covalent bonds. In organic compounds, carbon atoms bond to ____________ or other elements near carbon on the periodic table. Carbon atoms also bond to ____________ and can form long _______.

**Label the web below with the correct name for each model of methane.**

1. CH₄

2. H – C – H

3. Models of Methane

4.
Multiple Carbon-Carbon Bonds

Use with page 746.

Organize the outline below.

I. Ways that carbon atoms bond to each other
   A. ________________________________
      1. share ________________________________
      2. also called ________________________________
   B. ________________________________
      1. share ________________________________
      2. also called ________________________________
   C. ________________________________
      1. share ________________________________
      2. also called ________________________________

Draw models of each carbon-carbon bond and label them appropriately. Use the illustrations on page 710 of your text as a guide.

<table>
<thead>
<tr>
<th>Single Covalent Bond</th>
<th>Double Covalent Bond</th>
<th>Triple Covalent Bond</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Section 21.1 Introduction to Hydrocarbons (continued)

Main Idea

Refining Hydrocarbons
Use with pages 747–748.

Identify natural sources of hydrocarbons by completing the following statements.
The main natural source of hydrocarbons is _______, a complex mixture containing more than a thousand _______________.
Petroleum is more useful to humans when _______________ ________________, called _______. Separation is carried out by _______________, a process called fractional distillation.

Sequence the process of fractional distillation.
___ Vapors travel up through the column.
___ Temperature is controlled to remain near 400° at the bottom of the fractionating tower.
___ Hydrocarbons with fewer carbon atoms remain in the vapor phase until they reach regions of cooler temperatures farther up the column.
___ Hydrocarbons with more carbon atoms condense closer to the bottom or the tower and are drawn off.
___ Petroleum boils and gradually moves toward the top.

Match the names of these two processes with their definitions.
1. fractional distillation  2. cracking
   ________________ is done to break the larger molecules of petroleum components into smaller molecules.
   ________________ separates petroleum into simpler components.

Rating Gasoline
Use with pages 748–749.

Explain why branched-chain alkanes make better gasolines than straight-chain hydrocarbons.
Hydrocarbons
Section 21.2 Alkanes

Main Idea

Skim Section 2 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.

alkane

homologous series

parent chain

substituent group

cyclic hydrocarbon

cycloalkane

Academic Vocabulary

Define the following terms.

substitute
Section 21.2 Alkanes

**Main Idea**

Straight-Chain Alkanes

Use with pages 750–751.

**Details**

Compare and contrast the models in the table below.

<table>
<thead>
<tr>
<th>Type of Model</th>
<th>Description of Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Molecular formula</td>
<td></td>
</tr>
<tr>
<td>2. Structural formula</td>
<td></td>
</tr>
<tr>
<td>3. Space-filling model</td>
<td></td>
</tr>
<tr>
<td>4. Ball-and-stick model</td>
<td></td>
</tr>
</tbody>
</table>

Describe straight-chain alkanes by completing the following sentences.

The first four compounds in the straight-chain series of alkanes are _________________. The names of all alkanes end in ___. Because the first four alkanes were named before there was a complete understanding of alkane structures, their names do not have _____________ as do the alkanes with _______________ in a chain. Chemists use _______________ to save space.

Explain the structural formula of the following hydrocarbons. The first has been done for you.

1. Methane is formed from one atom of carbon and four atoms of hydrogen.
   
2. Butane is formed ________________.
   
3. Octane is formed ________________
   
4. Decane is formed ________________.

Analyze how the function of a homologous series is evidenced in the condensed structural formula of nonane.

__________________________

__________________________

__________________________

__________________________

__________________________
Section 21.2 Alkanes (continued)

Main Idea

Branched-Chain Alkanes

Use with page 752.

Details

Compare three characteristics of butane and isobutane.

Describe naming branched-chain alkanes.

A straight-chain and a branched-chain alkane can have the same molecular formula.

Therefore, the name of an organic compound also must describe

PRINCIPLE

Therefore, the name of an organic compound also must describe

NAMING PROCESS

Branched-chain alkanes are viewed as consisting of a

NAMING, PART 1

The longest continuous chain of carbon atoms is called

NAMING, PART 2

All side branches are called because they appear to substitute for a hydrogen atom in the straight chain.

NAMING, PART 3

Each alkane-based substituent group branching from the parent chain is named
Section 21.2 Alkanes (continued)

**Main Idea**

**Cycloalkanes**

Use with pages 755–756.

Organize the concept web below.

- cyclic alkanes
- cycloalkanes
- organic compounds that contain

the prefix *cyclo-* indicates a

possible to have three, four, five, six, or even more

represented by condensed, skeletal,

can have groups

**Properties of Alkanes**

Use with pages 757–758.

Classify the properties of alkanes into categories.

<table>
<thead>
<tr>
<th>General Properties (3)</th>
<th>Physical Properties (4)</th>
<th>Chemical Properties (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Hydrocarbons
Section 21.3 Alkenes and Alkynes

Main Idea

Scan Section 3 of your text. Focus on the headings, subheadings, boldfaced words, and the main ideas. Set the book aside and, in the space below, summarize the main ideas of this section.

Details

New Vocabulary

Use your text to define each term.

alkene

alkyne
Section 21.3 Alkenes and Alkynes (continued)

**Main Idea**

Alkenes

Use with pages 759–760.

**Details**

**Identify** five facts about alkenes as discussed in your text.

1. 

2. 

3. 

4. 

5. 

**Sequence** the factors involved in naming an alkene with four or more carbons in the chain using the web below and number the steps.

1. Change the –ane ending of the corresponding alkane to 

2. Specify the location of the 

3. Number the carbons in the parent chain starting 

4. Use only that number 

**Summarize** Use the following to help you take notes as you read Example Problem 21.3 in your text.

**Problem** Name the following alkene.
Section 21.3 Alkenes and Alkynes (continued)

1. Analyze the Problem
You are given a branch-chained alkene that contains one double bond and two alkyl groups. Follow the IUPAC rules to name the organic compound.

2. Solve for the Unknown
   a. The longest continuous carbon chain that includes the double bond contains _____ carbons. The _____ alkane is heptane, but the name is changed to _____ because a double bond is present.

   b. and c. Number the chain to give the lowest number to the double bond and name each substituent.

   d. Determine how many of each substituent is present, and assign the correct prefix to represent that number. Then, include the position numbers to get the complete prefix.

   e. The names of substituents ____________________________ ____________________________.

   f. Apply the complete prefix to the name of the parent alkene chain. Use commas to separate numbers and hyphens between numbers and words. Write the name ____________________________.

3. Evaluate the Answer
   The longest carbon chain includes the ________, and the position of the double bond has the _________________.
   Correct prefixes and alkyl-group names ____________________________.

Alkynes
Use with pages 762–764.

Compare and contrast alkenes and alkynes.
Hydrocarbons
Section 21.4 Hydrocarbon Isomers

Main Idea

Details

**Skim** Section 4 of your text. Write two questions that come to mind from reading the headings and the illustration captions.

1. 

2. 

**New Vocabulary**

Use your text to define each term.

- **isomer**
- **structural isomer**
- **stereoisomer**
- **geometric isomer**
- **chirality**
- **asymmetric carbon**
- **optical isomer**
- **optical rotation**
Section 21.4 Hydrocarbon Isomers (continued)

**Main Idea**

**Structural Isomers**
*Use with page 765.*

**Stereoisomers**
*Use with page 766.*

**Chirality**
*Use with page 767.*

---

**Organize the outline below.**

I. **Isomers:** Two or more compounds that have the same molecular formula but different molecular structures.

A. Two types of isomers

1. Structural isomers

   a. __________________________

   b. __________________________

      i. Examples include __________________________

2. Stereoisomers

   a. __________________________

      i. __________________________

   b. __________________________

      i. Result from different arrangements of groups around a double bond

      1. Possible __________________________ with *trans*-fatty acids.

      2. The __________________________ seem not to be as harmful.

---

**Describe chirality by completing the flow chart below.**

Chirality occurs whenever a compound contains an which has or attached to it.

These isomers are called The molecules are The four groups can be
Section 21.4 Hydrocarbon Isomers (continued)

**Main Idea**

**Optical Isomers**

Use with pages 768–769.

**Details**

Identify the types of isomers shown below. Which pair are optical isomers?

- **D-glyceraldehyde**
  - CHO
  - H – C – OH
  - CH₂OH

- **L-glyceraldehyde**
  - CHO
  - HO – C – H
  - CH₂OH

- **ethanol**
  - H
  - H
  - H – C – C – O
  - H – H

- **methoxymethane**
  - H
  - H
  - H – C – O – C – H
  - H – H

- **trans-1,2-dichloroethene**
  - H
  - Cl
  - C = C
  - Cl

- **cis-1,2-dichloroethene**
  - H
  - C
  - C = C
  - Cl

**COMPARE**

Explain what a pair of shoes and crystals of the organic compound tartaric acid have in common.
Hydrocarbons
Section 21.5 Aromatic Hydrocarbons

Main Idea

Details

Skim Section 5 of your text. Focus on the headings, subheadings, boldfaced words, and the main ideas. Summarize the main ideas of this section.

New Vocabulary

Use your text to define each term.

aromatic compound

aliphatic compound
Section 21.5 Aromatic Hydrocarbons (continued)

**Main Idea**

**Aromatic Compounds**

*Use with pages 771–772.*

**Details**

**Classify** the properties of aromatic and aliphatic compounds.

<table>
<thead>
<tr>
<th></th>
<th>Structural Characteristics</th>
<th>Reactivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aromatic Compounds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aliphatic Compounds</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Model** Draw a model of a fused ring system.

**Explain** how substituted benzene rings are numbered.

**Number** the substituted benzene ring in the structure below, then name the structure.

![Structure](image-url)
Hydrocarbons  Chapter Wrap-Up

Now that you have read the chapter, review what you have learned; list the types of models used to represent chemical compounds and name the different categories of hydrocarbons.

Hydrocarbons:                                Models:

Alkanes

________________________________________  __________________________
________________________________________  __________________________
________________________________________  __________________________

Alkenes

________________________________________

Alkynes

Isomers

________________________________________  __________________________
________________________________________  __________________________

Aromatic Aliphatic

Review

Use this checklist to help you study.

☐ Study your Science Notebook for this chapter.

☐ Study the definitions of vocabulary words.

☐ Review daily homework assignments.

☐ Reread the chapter and review 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.

Summarize

Explain how hydrocarbons have contributed to space exploration.
Substituted Hydrocarbons and Their Reactions

Before You Read

**Review Vocabulary**

Define the following terms.

*periodic table*

*compound*

*halogens*

*chemical bond*

*catalyst*

**Chapter 21**

Compare and contrast *stereoisomers with structural isomers.*
Skim Section 1 of your text. Write three questions that come to mind from reading the headings and the illustration captions.

1. 
2. 
3. 

Use your text to define each term.

**functional group**

**halocarbon**

**alkyl halide**

**aryl halide**

**substitution reaction**

**halogenation**
Section 22.1 Alkyl Halides and Aryl Halides (continued)

**Main Idea**

**Functional Groups**

*Use with pages 786–787.*

**Details**

Describe how a functional group can be helpful in determining how a molecule reacts.

Identify the meaning of each of the following symbols for functional groups.

* represents ________________

R and R’ represents ________________

Organize information about organic compounds and their functional groups by completing the table below.

<table>
<thead>
<tr>
<th>Compound Type</th>
<th>General Formula</th>
<th>Functional Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Halocarbon</td>
<td>R-OH</td>
<td>Halogen</td>
</tr>
<tr>
<td></td>
<td>R-NH2</td>
<td>Ether</td>
</tr>
<tr>
<td>Aldehyde</td>
<td></td>
<td>Carbonyl</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Carbonyl</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ester</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Amido</td>
</tr>
</tbody>
</table>
Section 22.1 Alkyl Halides and Aryl Halides (continued)

**Main Idea** —

Organic Compounds Containing Halogens

Use with pages 787–788.

Naming Halocarbons

Use with page 788.

Properties and Uses of Halocarbons

Use with page 789.

Substitution Reactions

Use with page 790.

**Details** —

**Compare and contrast** alkyl halides and aryl halides.

________________________________________________________________________

________________________________________________________________________

**Describe** how to name halocarbons by completing the following paragraph.

Organic molecules containing functional groups are given IUPAC names based on their ______________________. For the alkyl halides, a prefix indicates which ________ is present. The prefixes are formed by ______________________________.

**Examine** Table 22.2 on page 789. Write three observations you make regarding the compounds listed in the table.

1. ____________________________________________

2. ____________________________________________

3. ____________________________________________

**Sequence** the steps needed to add Cl₂ to ethane to create chloroethane. Use the reaction from the bottom of page 741 in your text as a reference.

1. ____________________________________________

2. ____________________________________________

3. ____________________________________________

4. ____________________________________________

**Create** another substitution reaction using Br₂ and methane. Label molecules in each part of the reaction.

________________________________________________________________________
Substituted Hydrocarbons and Their Reactions

Section 22.2 Alcohols, Ethers, and Amines

Main Idea

Scan Section 2 of your text. Use the checklist below as a guide.
- Read all section titles.
- Read all boldfaced words.
- Read all formulas.
- Look at all figures and read the captions.
- Think about what you already know about alcohols, ethers, and amines.

Write three facts you discovered about alcohols as you scanned the section.

1. 
2. 
3. 

Details

New Vocabulary

Use your text to define each term.

hydroxyl group
alcohol
denatured alcohol

Define the following terms and write the general formula for each term.

ether
amine

Academic Vocabulary

Define the following term.

bond

Name ___________________________ Date ___________________________
Section 22.2 Alcohols, Ethers, and Amines (continued)

**Main Idea**

**Alcohols**

*Use with pages 792–793.*

**Details**

**Describe alcohol by completing the following sentence.**

Because they readily form hydrogen bonds, alcohols have ______ boiling points and ______ water solubility than other organic compounds.

**Write the general formula for alcohol:**

_____________________

**Draw structures for the following molecules.**

1-butanol

2-butanol

---

**Ethers**

*Use with page 794.*

**Describe ethers by completing the following sentence.**

Ethers are similar to ______ as they are compounds in which oxygen is bonded to ______. Ethers are different from alcohols because the oxygen atom bonds with ___ carbon atoms. Ethers are much less ______ in water than alcohol because they have no ______ to donate to a hydrogen bond.
Section 22.2 Alcohols, Ethers, and Amines (continued)

**Main Idea**

Write the general formula for ethers:

Draw a structure for the following molecule.

ethyl ether

**Details**

Amines contain atoms bonded to carbon atoms in chains or rings. Amines are responsible for many of the associated with decay.

Complete the following sentence.

Amines contain _______ atoms bonded to carbon atoms in _______ chains or _______ rings. Amines are responsible for many of the _______ associated with decay.

Write the general formula for amines:

Draw a structure for the following molecule.

ethylamine
Substituted Hydrocarbons and Their Reactions
Section 22.3 Carbonyl Compounds

Main Idea

Skim Section 3 of your text. Write two questions that come to mind from reading the headings and the illustration captions.

1. ________________________________

2. ________________________________

New Vocabulary

Use your text to define each term.

ketone

______________________________

carboxylic acid

______________________________

carboxyl group

______________________________

ester

______________________________

amide

______________________________

Define the following terms and write the general formula of each.

carbonyl group

______________________________

aldehyde

______________________________

condensation reaction

______________________________
Organic Compounds Containing the Carbonyl Group

Use with pages 796–800.

Identify five important classes of organic compounds containing or made from carbonyl compounds:

a. __________________________

b. __________________________

c. __________________________

d. __________________________

e. __________________________

Describe the common structure of aldehydes and ketones.

Draw a molecule of a carboxylic acid.

Describe organic compounds that are derived from carboxylic acids by completing the following paragraph.

Several classes of organic compound have structures in which the __________________________ of a carboxylic acid is replaced by _____________ or _____________. The two most common types are _______________________.
Section 22.3 Carbonyl Compounds (continued)

Main Idea

Condensation Reactions
Use with page 801.

Sequence the steps for a condensation reaction.

___ A small molecule, such as water, is lost.
___ Two organic molecules combine.
___ A more complex molecule is formed.

Complete the following condensation reaction.
RCOOH + R’OH → ______________________

Summarize

Identify the functional group that corresponds to each of the following:

a. -ine at the end of each halogen name to –o __________________

b. adding –amine as the suffix __________________

c. -ane of the parent alkane to –ol __________________

d. replacing –e ending with –amide __________________

e. –e at the end of the name to –al __________________

f. –ane of the parent alkane to –anolic acid __________________

g. -ic acid ending replaced by –ate __________________

h. –e end of the alkane replaced by –one __________________
Substituted Hydrocarbons and Their Reactions

Section 22.4 Other Reactions of Organic Compounds

Main Idea

Details

Scan Section 4 of your text. Use the checklist below as a guide.

- Read all section titles.
- Read all boldfaced words.
- Read all formulas.
- Look at all figures and read the captions.

Write three facts you discovered about organic reactions.

1. 

2. 

3. 

New Vocabulary

Use your text to define each term.

elimination reaction

dehydrogenation reaction

dehydration reaction

addition reaction

hydration reaction

hydrogenation reaction
Classifying Reactions of Organic Substances

Use with pages 802–805.

Main Idea

Details

List what needs to happen for chemical reactions of organic substances to occur. Include when and why a catalyst might be needed.

1. 

2. 

3. 

Review the section and give an example formula for each of the following reaction types.

addition reaction

hydration reaction

dehydrogenation reaction

dehydration reaction

hydrogenation reaction

elimination reaction
Oxidation-Reduction Reactions

Many ______ compounds can be converted to other compounds by ______ and ______ reactions. ______ is the loss of ______. A substance is oxidized when it gains ______ or loses ______. Reduction is the _____ of electrons. A substance is reduced when it loses ______ or gains ______.

Predicting Products of Organic Reactions

Write the generic equation representing an addition reaction between an alkene and an alkyl halide.

Substitute the structure for cyclopentene and the formula for hydrogen bromide. From the equation, you can see that:

A ________ and a ________ add across the ________ to form an ________.

Draw the formula for the likely product.
Substituted Hydrocarbons and Their Reactions

Section 22.5 Polymers

Scan Section 5 of your text. Use the checklist below as a guide.

- Read all section titles.
- Read all boldfaced words.
- Read all tables and formulas.
- Look at all figures and read the captions.

Write three facts you discovered about polymers.

1. 
2. 
3. 

Use your text to define each term.

- polymer
- monomer
- polymerization reaction
- addition polymerization
- condensation polymerization
- thermoplastic
- thermosetting
The Age of Polymers
Use with page 809.

Reactions Used to Make Polymers
Use with page 810–811.

Identify three common polymers described in the text. Include their uses.

1. _________________________________________________________
2. _________________________________________________________
3. _________________________________________________________

Identify the monomers or polymers.

<table>
<thead>
<tr>
<th>Monomer (s)</th>
<th>Polymer (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethylene</td>
<td>Nylon 6.6</td>
</tr>
<tr>
<td>Urethane</td>
<td></td>
</tr>
</tbody>
</table>

Compare and contrast condensation polymerization with addition polymerization by placing the terms below into the Venn diagram.

• all atoms present in final product
• small by-product, usually water
• involves the bonding of monomers
**Main Idea**

**Common Polymers**

*Use with page 812.*

**Details**

**Identify** the common polymer. Use Table 22.4 in your text as a reference.

<table>
<thead>
<tr>
<th>Use</th>
<th>Polymers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foam furniture cushions</td>
<td></td>
</tr>
<tr>
<td>A planter</td>
<td></td>
</tr>
<tr>
<td>Nonstick cookware</td>
<td></td>
</tr>
<tr>
<td>Food wrap</td>
<td></td>
</tr>
<tr>
<td>Windows</td>
<td></td>
</tr>
<tr>
<td>Clothing</td>
<td></td>
</tr>
<tr>
<td>Carpet</td>
<td></td>
</tr>
<tr>
<td>Water pipes</td>
<td></td>
</tr>
<tr>
<td>Beverage containers</td>
<td></td>
</tr>
</tbody>
</table>

**Properties and Recycling of Polymers**

*Use with pages 813–814.*

**Identify** four reasons that many different polymers are widely used in manufacturing.

1. 

2. 

3. 

4. 

**Describe** the melting characteristics of thermoplastic polymers and thermosetting polymers.

Thermoplastic polymers _____________________________

______________________________

Thermosetting polymers _____________________________

______________________________
Discuss recycling by completing the following paragraph.

Americans are not efficient at recycling their plastics. Currently, only ____ of plastic waste is recycled. This low rate of _______ ______ is due in part to the _________________.

Plastics must be ______ according to _________________, which is ___________ and __________. The plastic industry has ________________ that indicate the ___________ of each plastic product to make the process easier on individuals.

Describe what the code of recycling polymers does. Give an example of the code from the textbook.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

REAL-WORLD CONNECTION

Describe some common polymers that you use every day.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
Substituted Hydrocarbons and Their Reactions  Chapter Wrap-Up

After reading this chapter, list three things you have learned about substituted hydrocarbons and their reactions.

1. 

2. 

3. 

Review

Study your Science Notebook for this chapter.

Study the definitions of vocabulary words.

Review daily homework assignments.

Reread the chapter and review 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

Examine the picture of spooled threads on page 736. Explain how monomers might be a part of the process that produces these spooled polymer threads.
## The Chemistry of Life

### Before You Read

**Review Vocabulary**

**Define the following terms.**

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>hydrogen bond</td>
<td></td>
</tr>
<tr>
<td>isomers</td>
<td></td>
</tr>
<tr>
<td>functional group</td>
<td></td>
</tr>
<tr>
<td>polymers</td>
<td></td>
</tr>
</tbody>
</table>

**Chapter 12**

**Illustrate** the hydrogen bonding between water molecules.

**Chapter 22**

**Illustrate** the molecules for flouroethane and 1,2 difluoropropane.
The Chemistry of Life
Section 23.1 Proteins

**Main Idea**

**Details**

*Skim Section 1 of your text. Focus on the headings, subheadings, boldfaced words, and the main ideas. Summarize three main ideas of this section.*

<table>
<thead>
<tr>
<th>New Vocabulary</th>
<th>Use your text to define each term.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>protein</strong></td>
<td><strong>amino acid</strong></td>
</tr>
<tr>
<td><strong>peptide bond</strong></td>
<td><strong>peptide</strong></td>
</tr>
<tr>
<td><strong>denaturation</strong></td>
<td></td>
</tr>
<tr>
<td><strong>enzyme</strong></td>
<td><strong>substrate</strong></td>
</tr>
<tr>
<td><strong>active site</strong></td>
<td></td>
</tr>
</tbody>
</table>

320  Proteins
Section 23.1 Proteins (continued)

**Main Idea**

**Protein Structure**  
*Use with pages 826–829.*

**Details**

*Draw and label a general amino acid with a variable side chain, an amino group, and a carboxyl group.*

**Describe** the structure of a dipeptide and its functional units.

**Rewrite** each of the following statements, making each true.

To function properly, each protein must be flat.

A dipeptide consists of an amino acid with two side chains.

**Complete** the following paragraph statements about peptide bonds.

When a peptide bond is formed, _____ is released in the process.  
This type of reaction is known as a ___________ reaction.
Section 23.1 Proteins (continued)

**Main Idea**

Identify the peptide bond between the following amino acids.

```
H   R1   H   R2
\    \    \    
N—C—C—N—C—C—OH
\    \    \    
H   H   O   H   O
```

**Details**

Explain why Gly-Phe is a different molecule than the Phe-Gly.

Draw an enzyme/substrate complex with the enzyme and substrates labeled.

The Many Functions of Proteins

Use with pages 829–831.
Describe how the following functions affect living organisms by giving an example from your text.

Enzymes: __________________________________________
___________________________________________________

Transport proteins: __________________________________
___________________________________________________

Structural proteins: __________________________________
___________________________________________________

Hormones: _________________________________________
___________________________________________________

Review the statements below and revise to make them correct.

1. Substrates bind to an enzyme site.
   ________________________________________________

2. An active site changes shape a great deal to accommodate the substrate.
   ________________________________________________
   ________________________________________________

3. An enzyme-substrate complex changes the enzyme, and it becomes part of the new molecule.
   ________________________________________________
   ________________________________________________
The Chemistry of Life
Section 23.2 Carbohydrates

Scan Section 2 of your text. Use the checklist below as a guide.

- Read all section titles.
- Read all boldfaced words.
- Look at all figures and read the captions.
- Think about what you already know about carbohydrates.

Write three facts you discovered about carbohydrates as you scanned the section.

1. 
2. 
3. 

New Vocabulary

Use your text to define each term.

- carbohydrate
- monosaccharide
- disaccharide
- polysaccharide
Section 23.2 Carbohydrates (continued)

**Main Idea**

**Kinds of Carbohydrates**

*Use with pages 832–834.*

**Details**

**Draw** the cyclic and open-chain structures of the monosaccharide glucose.

**Explain** how the monosaccharides glucose and galactose differ. Discuss why they would not react the same way in nature.

**Describe** the structure and composition of the following types of carbohydrates by completing this table.

<table>
<thead>
<tr>
<th>Carbohydrate</th>
<th>Example</th>
<th>Structure and composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>starch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>cellulose</td>
<td></td>
<td></td>
</tr>
<tr>
<td>glycogen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>glucose</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Scan Section 3 of your text. Use the checklist below as a guide.

- Read all section titles.
- Read all boldfaced words.
- Look at all figures and read the captions.
- Think about what you already know about lipids.

Write three facts you discovered about lipids as you scanned the section.

1. 
2. 
3. 

Use your text to define each term.

**lipid**

**fatty acid**

**triglyceride**

**saponification**

**phospholipid**

**wax**

**steroid**
Section 23.3 Lipids (continued)

Main Idea

What is a lipid?
Use with pages 835–839.

Details

Describe how a lipid differs from a protein or carbohydrate.

Compare and contrast saturated and unsaturated fatty acids. Give an example of each.

Explain the reactions that form triglycerides. Give the type of reaction as well as the substrates.
Section 23.3 Lipids (continued)

Main Idea

**Describe** how waxes are made and what their specific properties include.

Details

**Describe** a lipid that is not composed of fatty acid chains. Give an example.

**SYNTHESIZE**

List the important functions for each of the following types of lipids.

triglyceride

phospholipid

waxes

steroids
Skim Section 4 of your text. Write three questions that come to mind from reading the headings and the illustration captions.

1. 

2. 

3. 

Use your text to define each term.

*nucleic acid*

*nucleotide*
Section 23.4 Nucleic Acids (continued)

**Main Idea**

**Structure of Nucleic Acids**
*Use with page 840.*

**Details**

Draw a diagram of a nucleotide. Label all of the parts: sugar, phosphate group, and nitrogen-containing base.

[Diagram of a nucleotide with labeled parts]

Write a statement that differentiates between nucleotides and nucleic acids.

Sequence the events of DNA replication. The first one has been done for you.

1. Hydrogen bonds form between new nitrogen bases and the existing strand.
2. Two nucleotide strands unzip.
3. Nitrogen bases pair adenine with thymine, cytosine with guanine.
4. An enzyme breaks the hydrogen bonds between the nitrogen bases.
5. The nucleotide strands separate to expose the nitrogen bases.
6. Free nucleotides are delivered by enzymes from the surrounding environment.

Predict the complimentary base pairing given the following strand of nucleotides.
ATCTATCGGATATCTG
Section 23.4 Nucleic Acids (continued)

**Main Idea**

RNA

*Use with page 843.*

**Details**

**Identify** differences in DNA and RNA.

<table>
<thead>
<tr>
<th></th>
<th>DNA</th>
<th>RNA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrogen Bases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Function</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Form of strand</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**State** whether you would find each of the following in DNA, RNA, both, or neither. Explain your answer.

- A-A
- A-T
- C-G
- G-A
- A-U
- U-A

**REAL-WORLD CONNECTION**

Suppose you are an assistant to a forensic scientist who has found an unknown sample of DNA at a crime scene. Upon analysis, he finds it contains 22% thymine molecules. A DNA sample that contains 40% guanine is obtained from a suspect who is brought in. You ask for the suspect’s release. Explain your reasoning based on the bonding patterns of DNA nucleotides.

- ____________
- ____________
- ____________
- ____________
- ____________
- ____________
The Chemistry of Life
Section 23.5 Metabolism

Main Idea

**Skim** Section 5 of your text. Focus on the headings, subheadings, boldfaced words, and the main ideas. List three main ideas of this section.

1. 
2. 
3. 

New Vocabulary

Use your text to define each term.

- **metabolism**
- **catabolism**
- **anabolism**
- **ATP**
- **photosynthesis**
- **cellular respiration**
- **fermentation**

Academic Vocabulary

Define the following term.

- **conceptualize**
Section 23.5 Metabolism (continued)

Main Idea

Anabolism and Catabolism

Use with pages 844–845.

Details

Explain the relationship between metabolism, catabolism, and anabolism.

Explain how ATP is able to store and release energy in the cells of organisms.

Photosynthesis

Use with page 846.

Write the reaction of photosynthesis. Label the individual molecules.

Identify the redox process that occurs during photosynthesis.
Section 23.5 Metabolism (continued)

**Main Idea**

**Cellular Respiration**

*Use with page 846.*

**Details**

Write the reaction of cellular respiration. Be sure to label the individual molecules.

Identify the redox process that occurs during cellular respiration.

Summarize the relationship between photosynthesis and cellular respiration.
Section 23.5 Metabolism (continued)

Fermentation
*Use with pages 847–848.*

**Main Idea**
**Details**

**Compare and contrast** alcoholic fermentation and lactic acid fermentation.

---

**REAL-WORLD CONNECTION**

Explain why the redox processes that occur during photosynthesis are vital to life.
Now that you have read the chapter, review what you have learned. Write out the major concepts from the chapter.

Use this checklist to help you study.

☐ Study your Science Notebook for this chapter.
☐ Study the definitions of vocabulary words.
☐ Review daily homework assignments.
☐ Reread the chapter and review 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.
Nuclear Chemistry

Before You Read

Review Vocabulary

Define the following terms.

isotopes

nuclear reaction

electron

Chapter 4

Use your text to review the following concepts which will help you understand this chapter.

List the three kinds of subatomic particles discussed in Chapter 4.
1. .................................................................
2. .................................................................
3. .................................................................

Draw and label a nuclear model of the atom. Use Figure 4.14 as a reference.

.................................................................

Identify the primary factor in determining an atom’s stability.

.................................................................
Section 24.1 Nuclear Radiation

Main Idea

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.

radioisotope

X ray

penetrating power
### Main Idea

#### Comparison of Chemical and Nuclear Reactions

*Use with page 860.*

### Details

**Contrast** chemical and nuclear reactions.

<table>
<thead>
<tr>
<th>Chemical Reactions</th>
<th>Nuclear Reactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>bonds are</td>
<td>nuclei emit</td>
</tr>
<tr>
<td>and formed</td>
<td></td>
</tr>
<tr>
<td>atoms are</td>
<td>are converted into</td>
</tr>
<tr>
<td>though they may be</td>
<td>atoms of another element</td>
</tr>
<tr>
<td>rearranged</td>
<td></td>
</tr>
<tr>
<td>reaction rate</td>
<td>reaction rate</td>
</tr>
<tr>
<td>by pressure,</td>
<td>by pressure,</td>
</tr>
<tr>
<td>temperature,</td>
<td>temperature,</td>
</tr>
<tr>
<td>concentration, and</td>
<td>concentration,</td>
</tr>
<tr>
<td>catalyst</td>
<td>or catalyst</td>
</tr>
<tr>
<td>involve only valence</td>
<td>may involve protons,</td>
</tr>
<tr>
<td>energy changes</td>
<td>energy changes</td>
</tr>
</tbody>
</table>

### The Discovery of Radioactivity

*Use with pages 860–861.*

**Summarize** the discovery of radioactivity. Review the dates on the timeline below. Use your text to fill in the important achievements in radioactive research on those dates.

1895 Roentgen

1895 Becquerel

1898 The Curies

1903 The Curies and Becquerel

1911 Marie Curie
Section 24.1 Nuclear Radiation (continued)

**Main Idea**

Types of Radiation

*Use with pages 861–864.*

**Details**

Identify the common type of radiation signified by each symbol.

- $\alpha$
- $\beta$
- $\gamma$

Differentiate between each of the subatomic radiation particles mentioned in the chapter.

<table>
<thead>
<tr>
<th>Radiation Type</th>
<th>Charge</th>
<th>Mass</th>
<th>Relative Penetrating Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beta</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gamma</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Describe what happens when a radioactive nucleus emits an alpha particle.

Describe beta particles by completing the following statements.

A beta particle is a very fast-moving ________. To represent its insignificant mass, beta particles have a superscript of ______. A subscript of –1 denotes the _________ charge of beta particles. Beta particles have greater ________________ than alpha particles.

Describe what the subscript and superscript of zero tell you about gamma particles.
Scan Section 2, using the checklist below as a guide.
• Read all section titles and boldfaced words.
• Study all tables, graphs, and figures.

Write two facts you discovered about transmutation.
1. ______________________________________________________
2. ______________________________________________________

Use your text to define each term.
transmutation
nucleon
strong nuclear force
band of stability
positron emission
positron
electron capture
radioactive decay series
half-life
radiochemical dating
Section 24.2 Radioactive Decay (continued)

Contrast the properties of isotopes by imagining two eggs as models. One isotope would be created using hard-boiled eggs as building blocks, the other using raw eggs as building blocks. Explain which model would be more stable, and which would be more typical of known isotopes.

Summarize how the strong nuclear force helps to keep protons in a nucleus.

Describe the neutron-to-proton (n/p) ratio in nuclear stability.

The number of protons compared to the number of ________ in a ratio identifies the nuclear ratio. To some degree, the ________ of a nucleus can be correlated with its ____________ ratio.

As atomic number ________, more ________ are needed to balance the ____________ forces. Plotting the number of neutrons versus the number of ________ for all stable nuclei illustrates the ____________.

Analyze the relative stability of radioisotopes. Use Figure 25.8 as a guide.

1. a radioisotope with too many neutrons relative to its protons ______________________________________

2. a radioactive isotope ______________________________________

3. a nucleus with more than 83 protons ______________________________________

4. a nucleus with a high atomic number and a neutron-to-proton ratio of 1:5:1. ______________________________________
Writing and Balancing Nuclear Equations
Use with page 869.

Compare positron emission with electron capture.
Positron emission is ______________ that involves the emission of a _______ (particle with the same mass as an electron but opposite charge) from a nucleus. During this process, a _______ in the nucleus is converted into a neutron and a positron, and then the _______ is emitted.
Electron capture is ______________ that decreases the number of _______ in unstable nuclei lying below the ______________. This occurs when the nucleus of an atom draws in a surrounding _________, usually from the lowest energy level. The captured electron combines with a ______ to form a _________.

Contrast balanced chemical equations with balanced nuclear equations.
Balanced chemical equations conserve ______________ _______.
Balanced nuclear equations conserve ______________ _______.

Solve Read Example Problem 24.1 in your text.

You Try It

Problem
Write a balanced nuclear equation for the alpha decay of uranium-238 ($^{238}_{92}$U).

1. Analyze the Problem

Known: 

decay type: 

Unknown: 

2. Solve for the Unknown

Using each particle’s mass number, make sure the mass number is conserved on each side of the reaction arrow.

\[ \text{Mass number: } 238 = X + \underline{\hspace{2cm}} \quad X = 238 - 4 \]

Mass number of \( X \) = __

Using each particle’s atomic number, make sure the atomic number is conserved on each side of the reaction arrow.

\[ \text{Atomic number: } 92 = \underline{\hspace{2cm}} \quad X = 92 - \underline{\hspace{2cm}} \]

Atomic number of \( X \) = __

Use the periodic table to identify the unknown element.

______________

Write the balanced nuclear equation.

______________

Describe a radioactive decay series by completing the following paragraph.

A radioactive decay series is a series of _____________ that begins with a(n) _______ nucleus and ends in the formation of a stable _______. Both alpha decay and _________ are involved in the process.
Section 24.2 Radioactive Decay (continued)

**Main Idea**

Radioactive Decay Rates

*Use with pages 870–871.*

**Details**

Describe how Ernest Rutherford’s early experiments in inducing nuclear reactions led to modern particle accelerators.

Rutherford discovered that particles must move at extremely _____ to overcome electrostatic _____ and affect a target nucleus. Scientists have built on this to develop methods to accelerate particles to extreme speed using _____ and _____ fields. Particle accelerators use conventional and _______ magnets to force particles to move at high speeds.

Explain why some naturally occurring radioactive substances still remain on Earth.

---

**REAL-WORLD CONNECTION**

Suppose you want to join an after-school club. Two clubs interest you. In the photography club, there are a lot of members, but only a few who are truly interested (or proactive) about the topic. Most members just seem to have joined to be involved in an activity (or are neutral). The chemistry club, on the other hand, has fewer members, but there seems to be an equal number of truly interested (proactive) students as there are students without a lot of interest (neutrals). If human interactions followed the same laws as radioisotopes, explain which group would be more stable over the school year.
Main Idea

Calculating the Amount of Remaining Isotope

Use with Example Problem 24.2, page 872.

Details

Solve Read Example Problem 24.2 in your text.

You Try It

Problem

Determine the amount of an original sample of 2.0 grams of thorium-234 after 49 days. The half-life of thorium-234 is 24.5 days.

1. Analyze the Problem

   Known: Unknown:
   Initial amount = ________ Amount remaining = ? g
   Elapsed time (t) = ________
   Half-life (T) = ________

2. Solve for the Unknown

   Number of half-lives (n) = Elapsed time/Half-life
   \[ n = \frac{49}{24.5} = \text{________} \]
   Amount remaining = \[ \text{________} \]
   Amount remaining = \[ \text{________} \]
   Amount remaining = \[ \text{________} \]
   Amount remaining = \[ \text{________} \]

3. Evaluate the Answer

   After 49 days, _____ half-lives of thorium-234 have elapsed. The number of half-lives is equivalent to \((1/2)(1/2)\) or \(\text{______}\). The answer, _____ is equal to _____ the original quantity.

Radiochemical Dating

Use with pages 873–874.

Write the balanced nuclear equation for carbon dating.
# Nuclear Chemistry

## Section 24.3 Nuclear Reactions

**Main Idea**

**Details**

*Skim Section 3 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.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>induced transmutation</td>
<td></td>
</tr>
<tr>
<td>transuranium elements</td>
<td></td>
</tr>
<tr>
<td>mass defect</td>
<td></td>
</tr>
<tr>
<td>nuclear fission</td>
<td></td>
</tr>
<tr>
<td>critical mass</td>
<td></td>
</tr>
<tr>
<td>breeder reactor</td>
<td></td>
</tr>
<tr>
<td>nuclear fusion</td>
<td></td>
</tr>
<tr>
<td>thermonuclear reaction</td>
<td></td>
</tr>
</tbody>
</table>

**Academic Vocabulary**  Define the following term.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>generate</td>
<td></td>
</tr>
</tbody>
</table>
Induced Transmutation

Use with pages 875–876.

Sequence the steps in Rutherford's induced transformation of nitrogen-14 into oxygen.

\[ ^4_2 \text{He bombarding alpha particle} + \]

\[ \rightarrow \]

\[ ^{17}_8 \text{O} \text{ Oxygen atom} \]

\[ \text{p}^+ \text{ Proton} \]

and →

\[ \text{p}^+ \text{ proton} \]
Nuclear Chemistry

Section 24.3 Nuclear Reactions (continued)

Main Idea

Nuclear Reactions and Energy
Use with pages 877–878.

Details

Write Einstein’s equation. Be sure to include the measurement units.

Identify the three things you need to know to calculate mass defects.

a. 

b. 

c. 

Organize the steps in a nuclear fission reaction involving uranium.

1. A neutron 

2. The uranium 

3. The nucleus 

Explain why a fissionable material must have sufficient mass before a sustained reaction can take place.

Explain why a fissionable material must not have an excess of mass.
Nuclear Reactors
Use with pages 880–882.

Describe how a nuclear reactor creates energy. Include how the environment is protected from nuclear waste.
Nuclear fission produces _____________________________.
A common fuel is _____________________________. A neutron-emitting source _____________ and control rods absorb virtually all of the _________ produced in the reaction. Heat from a reaction is used to power ____________________________ which produce electrical power.

Nuclear Fusion
Use with pages 883–884.

Describe nuclear fusion by completing the following paragraph.
Nuclear fusion is the combining of atomic _______. Nuclear fusion reactions are capable of _____________________________.
The most common fusion reaction is the _______. Because of the energy requirements, fusion reactions are also known as _________________.

Explain why fusion reaction is not yet a practical source of everyday energy.
________________________________________
________________________________________
________________________________________
________________________________________

Real-World Connection
Create a metaphor from everyday life that will show the difference between nuclear fission and nuclear fusion.

Nuclear fusion requires ____________________________.
Nuclear fusion requires ____________________________.
Fusion is like: ____________________________
Fusion is like: ____________________________
Fusion is like: ____________________________
Fusion is like: ____________________________
Scan Section 4, using 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 radioactive decay.

Write three questions you have about nuclear radiation.

1. 

2. 

3. 

New Vocabulary

Use your text to define each term.

ionizing radiation

radiotracer
List and describe three methods of detecting radiation.

1. 

2. 

3. 

Describe how a radiotracer works.
A radiotracer is a ________ that emits ________________ and is used to signal the presence of _________ or specific substance. The fact that all of an element’s isotopes have the same ______________ makes the use of radioisotopes possible.

Discuss a common radiotracer that is used in medicine.
Iodine-131 is commonly used to detect ________ associated with the ___________. A doctor will give the patient a drink containing a small amount of iodine-131. The iodine-containing ____________ is then used to monitor the function of the thyroid gland.
Identify three factors that affect the possible damage to the body caused by ionizing radiation discussed in the textbook.

1. 

2. 

3. 

Discuss genetic and somatic damage caused by ionizing radiation.

Somatic damage affects 

Genetic damage can affect 

Create a warning label that will identify the dangers of a radioactive material to users.
After reading this chapter, list three important facts you have learned about nuclear chemistry.

1. 

2. 

3. 

**Review**

*Use this checklist to help you study.*

- [ ] Study your Science Notebook for this chapter.
- [ ] Study the definitions of vocabulary words.
- [ ] Review daily homework assignments.
- [ ] Reread the chapter and review 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**

Imagine you are watching a program on radiation with a friend. Your friend is afraid of all radiation. Explain to your friend some of the common useful applications of radiation.