About the Consultant

Douglas Fisher, Ph.D., is a Professor in the Department of Teacher Education at San Diego State University. He is the recipient of an International Reading Association Celebrate Literacy Award as well as a Christa McAuliffe award for Excellence in Teacher Education. He has published numerous articles on reading and literacy, differentiated instruction, and curriculum design as well as books, such as *Improving Adolescent Literacy: Strategies at Work* and *Responsive Curriculum Design in Secondary Schools: Meeting the Diverse Needs of Students*. He has taught a variety of courses in SDSU’s teacher credentialing program as well as graduate-level courses on English language development and literacy. He also has taught classes in English, writing, and literacy development to secondary school students.
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This note-taking guide is designed to help you succeed in learning science content. Chapters include:

**Covalent Bonding**

**Before You Read**

**Review Vocabulary**
- Ionic bond
- Octet rule

**Chapter 4**

Describe the structure of an atom.

**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
  - Cation: Li⁺
  - Anion: S²⁻
- KMnO₄
  - Cation: K⁺
  - Anion: MnO₄⁻
- Al₂O₃
  - Cation: Al³⁺
  - Anion: O²⁻

**Main Idea**

Skim Section 9.1 of your text. Write three questions that come to mind from reading the headings and the illustration captions.

1. _____________
2. _____________
3. _____________

**New Vocabulary**
- Covalent bond
- Molecule
- Lewis structure
- Sigma bond
- Pi bond
- Endothermic
- Exothermic

**Academic Vocabulary**

Use your text to define each term.

- _____________
- _____________

**Vocabulary helps you understand information better.**

**Note-taking tools based on the Cornell Note-Taking System.**

**Before You Read** helps you review concepts that you will need to know in order to understand the information that will be presented in the chapter.
Covalent Bonding Chapter Wrap-Up

After reading this chapter, list three key facts about covalent bonding.

1. 
2. 
3. 

Review

Use this checklist to help you study:

- Use the 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.

Write activities help you understand the information being presented and make connections between the concepts and the real-world.

You Try It problems help you work a problem similar to the Example Problem presented in the text.

The Chapter Wrap-Up helps you assess what you have learned in the chapter and prepare for chapter tests.
Note-Taking Tips

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>such as</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 emphasis 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.
Introduction to Chemistry

Before You Read

Before you read the chapter, write down four facts you know about chemistry.

1. _____________________________________________________________
2. _____________________________________________________________
3. _____________________________________________________________
4. _____________________________________________________________

Science Journal

Write three questions about scientific methods and research.

1. _____________________________________________________________
2. _____________________________________________________________
3. _____________________________________________________________

Academic Vocabulary

Define the following term.

______________________________
Introduction to Chemistry
Section 1.1 The Stories of Two Chemicals

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. ________________________________________________

New Vocabulary

ozone

chlorofluorocarbon

ozone hole

Academic Vocabulary

Define the following term.

chemical
The Ozone Layer

Use with pages 3-5.

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 The Stories of Two Chemicals (continued)

**Main Idea**

**Chlorofluorocarbons**

*Use with pages 5–6.*

**Analogy** Consider the two pictures in Figure 1-4. Explain in your own words how (a) helps illustrate what is happening in (b).

**Details**

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>
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<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
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<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>
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</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.

---

4 The Stories of Two Chemicals
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.

- chemistry
- matter
- mass
- weight

**Academic Vocabulary**

Define the following term.

- structure
Main Idea

Chemistry: The Central Science

Use with page 7.

Matter and its Characteristics

Use with pages 8–9.

Details

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

1. 
2. 
3. 
4. 
5. 
6.

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
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.

____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
### Main Idea

**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. 

### New Vocabulary

Use your text to define each term.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tr>
<td>scientific method</td>
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<td>hypothesis</td>
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<td>experiment</td>
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<td>control</td>
<td></td>
</tr>
<tr>
<td>conclusion</td>
<td></td>
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<tr>
<td>model</td>
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<tr>
<td>theory</td>
<td></td>
</tr>
<tr>
<td>scientific law</td>
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### A Systematic Approach


**Compare** the terms qualitative data and quantitative data.
Section 1.3 Scientific Methods (continued)

**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>
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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*.

___ Plan and set up one or more experiments to test one variable at a time.

___ Gather information using both qualitative data and quantitative data.

___ Observe, record, and analyze experimental data.

___ Develop a hypothesis, or tentative explanation based on observations.

___ Develop a theory or a scientific law.

___ Compare findings to the hypothesis, and form a conclusion.
Section 1.3 Scientific Methods (continued)

Use with page 13.

**Main Idea**

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.

**Details**

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): 

SYNTHESIZE
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. 

Use your text to define each term.

**New Vocabulary**
- pure research
- applied research
- technology

**Academic Vocabulary**

Define the following terms.

- analyze
- investigate
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.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
Section 1.4 Scientific Research (continued)

**Main Idea**

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.

**Synthesize**

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.
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. ________________________________
## Before You Read

### Review Vocabulary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>qualitative data</td>
<td></td>
</tr>
<tr>
<td>quantitative data</td>
<td></td>
</tr>
<tr>
<td>variable</td>
<td></td>
</tr>
<tr>
<td>analysis</td>
<td></td>
</tr>
</tbody>
</table>

**Define the following terms.**

### 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
Data Analysis
Section 2.1 Units of Measurement

Main Idea

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

1. _______________________________________

2. _______________________________________

3. _______________________________________

Details

Use your text to define each term.

base unit

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

density

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

New Vocabulary

Match the SI base units below with their functions.

second distance

meter temperature

kilogram time

liter mass

kelvin volume

Academic Vocabulary

Define the following term.

ratio

________________________________________________________________________

________________________________________________________________________
Section 2.1 Units of Measurement (continued)

Main Idea

SI Units

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

1. 
2. 
3. 
4. 
5. 

Base Units
Use with page 26.

Organize these prefixes from smallest to largest.

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

Derived Units
Use with pages 27–28.

 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

Main Idea

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.
   \[
   \text{mass} = \text{density} \times \text{volume}
   \]
   Rearrange the density equation to solve for mass.
   \[
   \text{mass} = \frac{14 \text{ g}}{5.0 \text{ mL}} = \text{ } \]
   Substitute the known values for \(14\) and \(5.0\) into the equation.

3. Evaluate the Answer
   The two sides of the equation should be \(16\).
   \[
   \text{density} = \frac{16 \text{ g}}{5.0 \text{ mL}} = \text{ }
   \]
   If you divide \(16\) g by \(5.0\) mL, you get \(3.2\) g/mL.

Temperature

Compare and contrast the kelvin scale and the Celsius scale.
Data Analysis
Section 2.2 Scientific Notation and Dimensional Analysis

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
scientific notation
Use your text to define each term.

conversion factor

dimensional analysis

Academic Vocabulary
convert
Define the following term.

Section 2.2 Scientific Notation and Dimensional Analysis (continued)

Main Idea

Convert Data into Scientific Notation
Use with Example Problem 2-2, page 31.

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 0.0012506 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.

The decimal point moved ___ places to the ___.

The decimal point moved ___ places to the ___.

Remove the extra zeros at the end or beginning of the factor.

Multiply the result by 10ⁿ 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 _______.
Using Multiple Conversion Factors

Use with Example Problem 24, page 35.

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.

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

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

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

3. Evaluate the Answer

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

\[
\frac{5.2 \text{ km}}{\text{s}} \times \frac{60 \text{ s}}{1 \text{ min}} = \frac{312 \text{ km}}{\text{min}} \times \frac{1000 \text{ m}}{1 \text{ min}} = \frac{\text{km}}{\text{min}}
\]
## Data Analysis
### Section 2.3 How reliable are measurements?

<table>
<thead>
<tr>
<th>Main Idea</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Skim</strong> Section 3 of your text. Focus on the headings, subheadings, boldfaced words, and main ideas. Summarize the main ideas of this section.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>New Vocabulary</th>
<th>Use your text to define each term.</th>
</tr>
</thead>
<tbody>
<tr>
<td>accuracy</td>
<td></td>
</tr>
<tr>
<td>precision</td>
<td></td>
</tr>
<tr>
<td>percent error</td>
<td></td>
</tr>
<tr>
<td>significant figure</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Academic Vocabulary</th>
<th>Define the following term.</th>
</tr>
</thead>
<tbody>
<tr>
<td>device</td>
<td></td>
</tr>
</tbody>
</table>
Section 2.3 How reliable are measurements? (continued)

**Main Idea**

**Percent Error**

*Use with page 37.*

**Calculating Percent Error**

*Use with Example Problem 2-5, page 38.*

**Details**

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

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

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

**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>−.19</td>
</tr>
<tr>
<td>2</td>
<td>1.68</td>
<td>.09</td>
</tr>
<tr>
<td>3</td>
<td>1.45</td>
<td>−.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.

   \[
   \text{percent error} = \left( \frac{\text{accepted value}}{\text{trial value}} \right) \times 100
   \]

   \[
   \text{percent error} = \left( \frac{1.59 \text{ g/cm}^3}{1.59 \text{ g/cm}^3} \right) \times 100 = \boxed{100}
   \]

   \[
   \text{percent error} = \left( \frac{1.59 \text{ g/cm}^3}{1.59 \text{ g/cm}^3} \right) \times 100 = \boxed{100}
   \]

   \[
   \text{percent error} = \left( \frac{1.59 \text{ g/cm}^3}{1.59 \text{ g/cm}^3} \right) \times 100 = \boxed{100}
   \]

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.
Identify the significant numbers below by drawing a circle around them. Use the five rules for recognizing significant digits on page 39 for reference.

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 = ___
Data Analysis
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.

Academic Vocabulary

identify

Define the following terms.

interpret

data
Graphing

*Use with page 43.*

**Main Idea**

**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>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Budget items</strong></td>
<td><strong>Percent</strong></td>
</tr>
<tr>
<td>Car insurance</td>
<td>45</td>
</tr>
<tr>
<td>Movies</td>
<td>6</td>
</tr>
<tr>
<td>Books</td>
<td>5</td>
</tr>
<tr>
<td>Clothing</td>
<td>30</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>4</td>
</tr>
<tr>
<td>Gas</td>
<td>10</td>
</tr>
</tbody>
</table>

The ____________ best displays the data in the Student Budget table because ____________________________

______________________________.
Section 2.4 Representing Data (continued)

**Main Idea**

**Line Graphs**
*Use with pages 44–45.*

**Details**

**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

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

Answer: _____  
Answer: _____

**Interpreting Graphs**
*Use with page 45.*

**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.
Data Analysis  Chapter Wrap-Up

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

density =

percent error = $\frac{\text{observed value} - \text{true value}}{\text{true value}} \times 100$

slope =

Conversion between temperature scales:

°C + ___ = ___

K − ___ = ___

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

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

Review

Vocabulary

Define the following terms.

matter

significant figure

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

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.

substance

physical property

extensive property

intensive property

chemical property

states of matter

vapor

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

Academic Vocabulary

Define the following term.

unique
Section 3.1 Properties of Matter (continued)

Physical and Chemical Properties of Matter

Use with pages 56–57.

Contrast intensive and extensive physical properties.

Describe how the person in Figure 3-1 uses the physical property of density to separate gold from pyrite (fool’s gold).

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 3.1 Properties of Matter (continued)

**Main Idea**

**Details**

**States of Matter**

*Use with pages 58–59.*

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

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

**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 3.2 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

- physical change 
- chemical change 
- law of conservation of mass

Use your text to define each term.

Academic Vocabulary

- constant

Define the following term.
Changes in Matter (continued)

Main Idea

Physical and Chemical Changes
Use with pages 61–62.

Details

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

1. silver spoon tarnishes __
   Explanation: ________________________________

2. crushing an aluminum can __
   Explanation: ________________________________

3. freezing water __
   Explanation: ________________________________

4. burning wood __
   Explanation: ________________________________

5. copper turns a greenish color __
   Explanation: ________________________________

6. 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
Section 3.2 Changes in Matter (continued)

**Conservation of Mass**  
*Use with Example Problem 3-1, page 64.*

**Main Idea**

**Details**

---

**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
Matter—Properties and Changes
Section 3.3 Mixtures of Matter

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

mixture

heterogeneous mixture

homogeneous mixture

solution

filtration

distillation

crystallization

chromatography

Academic Vocabulary

component

Define the following term.
Section 3.3 Mixtures of Matter (continued)

**Main Idea**

**Mixtures**

*Use with page 66.*

**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: __________________________
Main Idea

Technique 4: ___________

How it is done: ____________________________________________________________

__________________________

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

__ Mix the sand and salt mixture with water.
   Physical property used: ___________________________
   __________________________

__ Boil the salt and water mixture, leaving the salt behind.
   Physical property used: ___________________________
   __________________________

__ Separate the iron filings from the sand and salt by using a magnet.
   Physical property used: ___________________________
   __________________________

__ 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 in Figure 3-18. 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**

---

**Academic Vocabulary**

Define the following term.

- **stable**
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 3-17. Write a brief description of the information the concept map is conveying.

Describe how the periodic table organizes elements.

Explain how Figure 3-20 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 page 75.

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 76–77.

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.
Matter—Properties and Changes  Chapter Wrap-Up

After reading this chapter, list three things you have learned about the properties and changes in matter.

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 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.**

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>scientific law</td>
<td></td>
</tr>
<tr>
<td>theory</td>
<td></td>
</tr>
<tr>
<td>element</td>
<td></td>
</tr>
<tr>
<td>law of definite proportions</td>
<td></td>
</tr>
<tr>
<td>law of multiple proportions</td>
<td></td>
</tr>
</tbody>
</table>

**Describe three things that you already know about the atom.**

1. 
2. 
3. 
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. ____________________________________________

Use your text to define each term.

Dalton’s atomic theory

atom

Define the following term.

accurate

conclude

reveal
### Section 4.1 Early Theories of Matter (continued)

**Main Idea**

**The Philosophers**

*Use with pages 87–89.*

**John Dalton**

*Use with pages 89–90.*

**Details**

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

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

**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 __________.
Section 4.1 Early Theories of Matter (continued)

**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>X</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>X</td>
<td></td>
</tr>
<tr>
<td>Atoms cannot be created.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atoms cannot be destroyed.</td>
<td>X</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>

**Defining the Atom**

*Use with pages 90–91.*

**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 __________.

**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 Subatomic Particles and the Nuclear Atom

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 subatomic particles.
1. 
2. 
3. 

New Vocabulary
Use your text to define each term.
cathode ray


electron


nucleus


proton


neutron


Academic Vocabulary
Define the following term.
concentrate
Section 4.2 Subatomic Particles and the Nuclear Atom (continued)

**Main Idea**

Discovering the Electron

*Use with pages 92–94.*

**Details**

Summarize the information you learned from cathode ray experiments. Use Figure 4-8 for reference.

- **Cathode Ray Experiment**
  - Altering the gas in the tube and the material used for the cathode have no effect.
  - Cathode ray is deflected in a magnetic field.
  - Cathode ray is deflected toward the positively charged plate by an electric field.
  - Proves:
  - Indicates:
  - Proves:

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

1. __________________________________________
2. __________________________________________
3. __________________________________________
**Main Idea**

**The Nuclear Atom**
*Use with pages 94–95.*

**Details**

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 4-1 for reference.

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

Main Idea

**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. 

Details

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

New Vocabulary

Academic Vocabulary

Define the following term.

percent
Section 4.3 How Atoms Differ (continued)

Main Idea

Atomic Number
Use with page 98.

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
      An element with an atomic number of 11 is _____________.
   b. Atom 2
      Atomic number = number of protons = number of electrons
      Atomic number = number of protons = ______
      An 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:

- **Carbon-12**
  - Mass number is ______
  - Atomic number is ______

- **Carbon-13**
  - Mass number is ______
  - Atomic number is ______

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 Individual Atoms

Use with page 102.

Calculating Atomic Mass

Use with Example Problem 4-3, page 103.

Details

**Mass of Individual Atoms**

Use with page 102.

**Calculating Atomic Mass**

Use with Example Problem 4-3, page 103.

**Isotope Abundance for Element X**

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Mass (amu)</th>
<th>Percent abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>(^6\text{X})</td>
<td>6.015</td>
<td>7.5%</td>
</tr>
<tr>
<td>(^7\text{X})</td>
<td>7.016</td>
<td>92.5%</td>
</tr>
</tbody>
</table>

**Main Idea**

Explain why the mass number for chlorine is more than 35. Use Figure 4-17 for reference.

Elements can have several isotopes. Each isotope has a different number of neutrons. Therefore each isotope has a different mass. The atomic mass of an element is a weighted average mass of all the isotopes of that element.

**Summarize**

Fill in the blanks to help you take notes while you read Example Problem 4-3.

**Problem**

Given the table in the left margin, the mass of an unknown element X. Then, how is this element identified?

1. **Analyze the problem**

   **Known:**

   Unknown:

   For isotope \(^6\text{X}\):
   
   \[
   \text{mass} = \text{________} \times \text{mass of element X} = ?
   \]
   
   \[
   \text{abundance} = \text{________} \times \text{abundance of element X} = ?
   \]
   
   For isotope \(^7\text{X}\):
   
   \[
   \text{mass} = \text{________}
   \]
   
   \[
   \text{abundance} = \text{________}
   \]

2. **Solve for the unknown**

   **Mass contribution**
   
   \[
   \text{For } ^6\text{X}: \text{Mass contribution} = \text{________} = \text{________}
   \]
   
   \[
   \text{For } ^7\text{X}: \text{Mass contribution} = \text{________} = \text{________}
   \]
   
   Sum the mass contributions to find the atomic mass.
   
   \[
   \text{________} \text{ of } X = \text{________} = \text{________}
   \]
   
   Use the ________ to identify the element.
   
   The element with an atomic mass of 6.941 amu is ________.

3. **Evaluate the answer**

   The number of neutrons does equal the ________ minus the ________ of ________. or number of ________.
The Structure of the Atom
Section 4.4 Unstable Nuclei and Radioactive Decay

Main Idea  Details

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.

nuclear reaction

radioactivity

radiation

radioactive decay

alpha radiation

alpha particle

nuclear equation

beta radiation

beta particle

gamma ray
Radioactivity
Use with pages 105–106.

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>( ^4_2 \text{He} )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass (amu)</td>
<td></td>
<td>1/1840</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.
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.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

56   Chapter Wrap-Up
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. ______________________________________
Electrons in Atoms
Section 5.1 Light and Quantized Energy

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
- electromagnetic radiation
- wavelength
- frequency
- amplitude
- electromagnetic spectrum
- quantum
- Planck’s constant
- photoelectric effect
- photon
- atomic emission spectrum

Use your text to define each term.
Section 5.1 Light and Quantized Energy (continued)

**Main Idea**

The Nuclear Atom and Unanswered Questions

*Use with page 117.*

**Details**

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

1. ____________________________________________________________

2. ____________________________________________________________

3. ____________________________________________________________

**Wave Nature of Light**

*Use with page 118.*

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

![Wave Diagram]

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

Calculating Wavelength of an EM Wave

Use with Example Problem 5-1, page 121.

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: \(\nu = \) \(\) 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 \(c = \lambda \nu\).

2. Solve for the Unknown

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

   If \(c = \lambda \nu\), then \(\lambda = \)

   Substitute \(c\) and the frequency of the radio wave, \(\nu\), into the equation. Note that hertz is equivalent to \(1/\text{s}\) or \(\text{s}^{-1}\).

   \(\lambda = \)

   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 page 122.

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

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.

- ground state
- de Broglie equation
- Heisenberg uncertainty principle
- quantum mechanical model of the atom
- atom orbital
- principal quantum number
- principal energy level
- energy sublevel

Academic Vocabulary

Define the following term.

- interact
Section 5.2 Quantum Theory and the Atom (continued)

**Main Idea**

**Bohr Model of the Atom**
*Use with page 127.*

**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>Balmer</th>
<th>Paschen</th>
<th>Lyman</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
<td>2.</td>
<td>2.</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 _________.
Section 5.2 Quantum Theory and the Atom (continued)

Main Idea

The Heisenberg Uncertainty Principle
Use with page 131.

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

Hydrogen’s Atomic Orbitals
Use with page 133.

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.
# Electrons in Atoms

## Section 5.3 Electron Configurations

### Main Idea

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

### Details

**New Vocabulary**

*Use your text to define each term.*

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>electron configuration</td>
<td></td>
</tr>
<tr>
<td>aufbau principle</td>
<td></td>
</tr>
<tr>
<td>Pauli exclusion principle</td>
<td></td>
</tr>
<tr>
<td>Hund’s rule</td>
<td></td>
</tr>
<tr>
<td>valence electron</td>
<td></td>
</tr>
<tr>
<td>electron-dot structure</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>nuclear</td>
<td></td>
</tr>
</tbody>
</table>
Ground-State Electronic Configurations

Orbital Diagrams and Electron Configuration Notations

Valence Electrons

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 ____________________________.
Electrons in Atoms

Section 5.3 Electron Configurations (continued)

[Main Idea]

**Writing Electron-Dot Configurations**

*Use with Example Problem 5-3, page 139.*

[Solve] *Read Example Problem 5-3 in your text.*

[Details]

**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.

________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________
The Periodic Table and Periodic Law

Before You Read

Define the following terms.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>atom</td>
<td></td>
</tr>
<tr>
<td>electron configuration</td>
<td></td>
</tr>
<tr>
<td>valence electrons</td>
<td></td>
</tr>
<tr>
<td>electron-dot structure</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Details</th>
</tr>
</thead>
</table>

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. 

New Vocabulary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>periodic law</td>
<td></td>
</tr>
<tr>
<td>group</td>
<td></td>
</tr>
<tr>
<td>period</td>
<td></td>
</tr>
<tr>
<td>representative element</td>
<td></td>
</tr>
<tr>
<td>transition element</td>
<td></td>
</tr>
<tr>
<td>metal</td>
<td></td>
</tr>
<tr>
<td>alkali metal</td>
<td></td>
</tr>
<tr>
<td>alkaline earth metal</td>
<td></td>
</tr>
<tr>
<td>transition metal</td>
<td></td>
</tr>
<tr>
<td>inner transition metal</td>
<td></td>
</tr>
<tr>
<td>nonmetal</td>
<td></td>
</tr>
<tr>
<td>halogen</td>
<td></td>
</tr>
<tr>
<td>noble gas</td>
<td></td>
</tr>
<tr>
<td>metalloid</td>
<td></td>
</tr>
</tbody>
</table>
Section 6.1 Development of the Modern Periodic Table (continued)

### Main Idea

**History of the Periodic Table’s Development**

*Use with pages 151–154.*

**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, ___________.

### Determine

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

- alkali metals
- alkaline earth metals
- halogens
- metals
- transition elements
- noble gases

**Hint:** colored pencils might be helpful. Be sure to include a legend.

**The Modern Periodic Table**

*Use with pages 154–158.*

- **Sequence** the events that helped develop the periodic table.
- **Determine** where you can find each of the following groups of elements on the periodic table below.
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 ______

are called representative elements

which possess ______

---

Groups 1B to 8B

are called ______

divided into

inner transition metals

transition metals earth metals

the ______ and actinide series

located at ______

---

1A all metals

except ______

more reactive than 2A ______

---

7A alkaline ______

halogens ______

---

8A ______ unreactive ______

Section 6.1 Development of the Modern Periodic Table (continued)

Main Idea

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 6-4 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

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. 

Define the following terms.

- corresponding
- significant
- transit
- sphere
Organizing the Elements by Electron Configuration

Use with page 159.

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. For representative elements, group number matches the ____________________________.
      a. All elements in group 1A have ____________________________.
      b. All elements in group 2A have ____________________________.
   2. Helium, in group 8A, 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 160–161.

**Details**

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

<table>
<thead>
<tr>
<th>Type of Occupied Element</th>
<th>Periodic Table Groups</th>
<th>Orbitals</th>
</tr>
</thead>
<tbody>
<tr>
<td>s-block</td>
<td></td>
<td>representative elements</td>
</tr>
<tr>
<td>p-block</td>
<td></td>
<td>p</td>
</tr>
<tr>
<td>d-block</td>
<td>3B to 2B</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.
### 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 tables.
- Look at all pictures and read the captions.

**Write** three facts that you discovered about periodic trends.

1. 

2. 

3. 

### Details

**New Vocabulary**

Use your text to define each term.

- **ion**

- **ionization energy**

- **octet rule**

- **electronegativity**

**Academic Vocabulary**

Define the following term.

- **trend**
Main Idea

Atomic Radius

Use with pages 163–164.

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.

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 165–166.

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 loses electrons</td>
<td>becomes negative</td>
<td>increases</td>
</tr>
<tr>
<td>atom gains electrons</td>
<td>becomes positive</td>
<td></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.

Details

Ionization Energy
Use with pages 167–168.

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 pages 168–169.

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.

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________
The Elements

Before You Read

Chapter 5

Write the electron configurations for the following elements.

Strontium: ____________________________
Selenium: ____________________________
Cesium: ______________________________
Cobalt: ______________________________
Antimony: ____________________________
Cadmium: ____________________________
Krypton: _____________________________

Chapter 6

List the general properties of metals.

____________________________________
____________________________________
____________________________________

List the general properties of nonmetals.

____________________________________
____________________________________
____________________________________

List the general properties of metalloids.

____________________________________
The Elements
Section 7.1 Properties of s-Block Elements

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 the following term.

diagonal relationship

Define the following terms.

Physical (property)

chemical (property)

element

react
Section 7.1 Properties of s-Block Elements (continued)

**Representative Elements**  
Use with pages 179–180.

**Hydrogen**  
Use with page 180.

**Group 1A Alkali Metals**  
Use with pages 181–182.

**Main Idea**

**Details**

Describe the properties of elements by completing the following statements.

The properties of elements within a group are similar, but not _______ because the elements share the same number of valence electrons, but a different number of _________________.

Often, the lightest element in a Period 2 group has more in common with the ____________ in the next group than with the _______ element in its own group. These close relationships between elements in ________________ are called _____________.

Analyze hydrogen by completing the following statements.

The mass of the universe contains ____________ hydrogen by mass. Hydrogen exists naturally as the following three isotopes:

1. ______—____ proton; no neutrons; _____% of hydrogen
2. deuterium—____ proton(s); ____ neutron(s); _____% of hydrogen
3. ______—____ proton(s); two neutron(s), and is __________

Identify the atomic, physical, and chemical characteristics of Group 1A elements.

Atomic: ____________________________

_______________________________

Physical: __________________________

_______________________________

Chemical: _________________________

_______________________________

Write the symbols for Group 1A elements in the order of most reactive to least reactive.
Section 7.1 Properties of s-Block Elements (continued)

**Main Idea**

**Group 2A: Alkaline Earth Metals**

*Use with pages 183–185.*

**Details**

**Identify** the atomic, physical, and chemical characteristics of Group 2A elements.

Atomic: __________________________________________

Physical: _________________________________________

Chemical: _________________________________________

**Write** the symbols for Group 2A elements in the order of most reactive to least reactive.

**Compare** the properties of lithium and magnesium that account for their diagonal relationship.

<table>
<thead>
<tr>
<th>Lithium</th>
<th>Property</th>
<th>Magnesium</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>atomic radius</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ionic radius</td>
<td></td>
</tr>
<tr>
<td></td>
<td>reaction with water</td>
<td></td>
</tr>
</tbody>
</table>

**Real-World Connection**

Several s-block elements are important in making products we use every day. Describe a product or a use you are familiar with for the elements listed below. Use pages 181–185 as a guide.

sodium: _________________________________________
calcium: _________________________________________
potassium: ________________________________________
magnesium: _______________________________________
strontium: _______________________________________
barium: _________________________________________
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 four facts that you discovered about p-block elements as you scanned the section.
1. ________________________________
2. ________________________________
3. ________________________________
4. ________________________________

Use your text to define each term.

mineral

ore

allotropes

Define the following term.

compound
Section 7.2 Properties of p-Block Elements (continued)

Main Idea

Group 3A: The Boron Group

Use with pages 186–187.

Details

Compare the properties of Group 3A elements based on whether a property applies to all, some, or one of the elements in the group.

- always found combined with other elements in nature
- lose three valence electrons to form ions with a 3+ charge
- can form ions with a 1+ charge
- abundant in Earth’s crust
- remains liquid in a wide temperature range

<table>
<thead>
<tr>
<th>One</th>
<th>Some</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
</tbody>
</table>

Describe some common properties of Group 4A elements by completing the table below.

<table>
<thead>
<tr>
<th>Element</th>
<th>Property</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>can take both hard and soft forms in a solid state</td>
</tr>
<tr>
<td></td>
<td>similar except for toxicity</td>
</tr>
<tr>
<td></td>
<td>occurs most often combined with oxygen</td>
</tr>
<tr>
<td></td>
<td>found in most organic compounds</td>
</tr>
</tbody>
</table>
Group 5A: The Nitrogen Group

Consider Group 5A. Complete the following outline on the nitrogen group.

I. Nitrogen
   A. Role in biology
      1. component in proteins and ______________________
      ______________________
      2. bacteria in soil convert molecular nitrogen into __________
      ______________________
   B. Uses
      1. ammonia: ______________________
      2. nitric acid: ______________________

II. Phosphorus
   A. Reactivity with oxygen
      1. white phosphorus: ______________________
      2. red phosphorus: ______________________
   B. Uses
      1. phosphate compounds found in ______________________
      ______________________
      2. a common ingredient in ______________________

III. Arsenic, antimony, and bismuth
   A. Properties
      1. less abundant ______________________
      2. among the oldest ______________________
   B. Uses
      1. antimony and sulfur was used ______________________
      2. an alloy of tin and antimony forms ______________________
      3. bismuth is used in a popular remedy for ______________________

Main Idea ———— Details
**Section 7.2 Properties of p-Block Elements** (continued)

**Main Idea**

**Group 6A: The Oxygen Group**

*Use with pages 192–194.*

**Describe properties of the oxygen group by completing the following statements.**

1. Group 6A elements are mostly _______ and tend to gain ____ electrons to form ions with a ____ charge.

2. An allotrope of oxygen, ____, makes up about 21% of the ____________.

3. Oxygen is important in _____________ for plants and animals.

4. Sulfur has ____ allotropes.

5. Sulfur dioxide, in the atmosphere, contributes to ________.

6. Selenium is used in dietary _____________.

**Group 7A: The Halogens**

*Use with pages 194–195.*

**Match the halogen listed on the left with its characteristics on the right.**

<table>
<thead>
<tr>
<th>Fluorine</th>
<th>used for bleaching, rust removal, and manufacturing plastics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iodine</td>
<td>used to prevent tooth decay and to coat non-stick cookware</td>
</tr>
<tr>
<td>Chlorine</td>
<td>used as a nutrient added to salt</td>
</tr>
</tbody>
</table>

**Group 8A: Noble Gases**

*Use with page 196.*

**Analyze why helium is the most abundant element in the universe yet is rare on Earth.**

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________
The Elements
Section 7.3 Properties of d-Block and f-Block Elements

Main Idea

Details

Skim Section 1 of your text. Use the following checklist 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 the subject.

Write three facts you discovered about environmental chemistry.
1. __________________________________________________________
2. __________________________________________________________
3. __________________________________________________________

New Vocabulary

lanthanide series

actinide series

ferromagnetism

metallurgy

Academic Vocabulary

Define the following term.
structural
Section 7.3 Properties of d-Block and f-Block Elements (continued)

Main Idea

Transition Metals

Use with pages 197–200.

Identify three atomic properties of transition metals that are shared across a given period.

1. __________________________________________________________________________

2. __________________________________________________________________________

3. __________________________________________________________________________

List four physical properties of transition metals that vary with the number of unpaired electrons.

1. __________________________________________________________________________

2. __________________________________________________________________________

3. __________________________________________________________________________

4. __________________________________________________________________________

Explain how the number of unpaired electrons relates to the number of ions the metal can form and the variety of colors that compounds of those ions can have.

_____________________________________________________________________________

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Section 7.3 Properties of d-Block and f-Block Elements (continued)

Main Idea

Use with page 200.

Details

Identify the transition metal that is found in the greatest number of countries and list the countries in which it is found.

Describe some of the uses for the following d-block and f-block elements.

Copper

Iron

Neodymium

Europium

Cerium

Uranium

Plutonium

Americium
Chapter Wrap-Up

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

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 number of electrons in the s-block, p-block, and d-block affects the behavior of an element.
Ionization Energy

Chapter 5
Create electron-dot diagrams for the following elements.

aluminum

calcium:

arsenic:

tellurium:

xenon:
Ionics Compounds
Section 8.1 Forming Chemical Bonds

Main Idea

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. _______________________________________________________________________________

Details

Use your text to define each term.

chemical bond
_______________________________________________________________________________
cation
_______________________________________________________________________________
anion
_______________________________________________________________________________

New Vocabulary

Academic Vocabulary

Define the following term.

element
_______________________________________________________________________________
Section 8.1 Forming Chemical Bonds (continued)

Chemical Bonds

Use with pages 211–214.

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, ______________.

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

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]6s¹

O: [He]2s²2p⁴

Ga: [Ar]4s²3d¹⁰4p¹

Br: [Ar]4s²3d¹⁰4p⁵

Ag: [Kr]5s¹4d¹⁰

Sc: [Ar]4s²3d¹
Sequence the first group of elements in order of increasing ionization energy. Sequence the second group of elements in order of increasing electron affinity.

First Group                                      Second Group
____  K → K^+                                       ____  P → P^{3–}
____  Ne → Ne^+                                   ____  O → O^{2–}
____  P → P^{5+}                                   ____  Xe → Xe^{–}
____  Fe → Fe^{2+}                                ____  S → S^{2–}
____  Rb → Rb^{+}                                 ____  I → I^{–}
____  Mg → Mg^{2+}                                ____  F → F^{–}

Identify the following ions.

Ag^{+}  ____________________________
Li^{+}  ____________________________
Br^{–}  ____________________________
Ca^{2+} ____________________________
S^{2–}  ____________________________
B^{3+}  ____________________________
As^{3–} ____________________________
H^{–}  ____________________________
Cd^{2+} ____________________________
Se^{2–} ____________________________
Ionic Compounds
Section 8.2 The Formation and Nature of Ionic Bonds

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.

**ionic bond**

**electrolyte**

**lattice energy**

**Academic Vocabulary**

Define the following term.

**conduct**
Formation and Nature of Ionic Bonds

Main Idea

Formation of an Ionic Compound
Use with Example Problem 8-1, page 217.

Details

Solve Read Example Problem 8-1 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.
   \[ \text{boron ions (3+/boron ion)} + \text{selenide ions (selenide ion)} = (3+) + (\underline{\text{ }} \underline{\text{ }} ) = 0 \]
Section 8.2 The Formation and Nature of Ionic Bonds

Properties of Ionic Compounds
Use with pages 217–220.

Main Idea

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. ____________________________________________

New Vocabulary

*Use your text to define each term.*

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

Section 8.3 Names and Formulas for Ionic Compounds (continued)

Main Idea

Formulas for Ionic Compounds

Determining the Formula for an Ionic Compound

Use with Example Problem 8-3, page 223.

Details

Solve Read Example Problem 8-3 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 for med is ______.

3. Evaluate the Answer

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

Ca ion(s) (2+/Ca ion) + Cl ions (1−/Cl ion) = 0

Solve Read Example Problem 8-4 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: ________
2. Solve for the Unknown
   The smallest number that is divisible by both ionic charges is \( \text{____, so } \), so ___ bromate ions combine with ___ calcium ion. The formula for the ionic compound formed is to form ___.

3. Evaluate the Answer
   The overall charge on one formula unit of this compound is zero.
   
   1 Ca ion (2+/Ca ion) + \( \text{____} \) BrO\(_3\) ions (1−/BrO\(_3\) 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.

- CN\(^-\)
- MnO\(_4\)\(^-\)
- Ba\(^{2+}\)
- Fe(CN)\(_6\)\(^4-\)
- NH\(_4\)\(^+\)
- N\(^3-\)
- Hg\(_2\)\(^{2+}\)
- S\(_2\)O\(_3\)\(^2-\)
- O\(^2-\)

Identify the ionic compounds listed below.

- CaO
- KMnO\(_4\)
- Sr(IO\(_3\))\(_2\)
- NH\(_4\)OH
- Fe\(_2\)S\(_3\)
- Sn(NO\(_3\))\(_4\)
- Pb\(_3\)(PO\(_4\))\(_2\)
- Hg\(_2\)SO\(_4\)
- PtCl\(_4\)
Ionic Compounds
Section 8.4 Metallic Bonds and Properties of Metals

Main Idea

Details

Skim Section 4 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.

electron sea model

delocalized electrons

metallic bond

alloy

Academic Vocabulary

Define the following term.

interact
Metallic Bonds

Use with pages 228–229.

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 8.4 Metallic Bonds and Properties of Metals (continued)

**Main Idea**

**Metal Alloys**

*Use with pages 230–231.*

**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 8-8 as a reference.

<table>
<thead>
<tr>
<th>Composition</th>
<th>Common Name</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.

__________________________
__________________________
__________________________
__________________________
__________________________
__________________________
__________________________
__________________________
__________________________
**Ionic Compounds  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.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
# Covalent Bonding

## Before You Read

### Review Vocabulary

**Define the following terms.**

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ionic bond</td>
<td></td>
</tr>
<tr>
<td>octet rule</td>
<td></td>
</tr>
</tbody>
</table>

### Chapter 4

**Describe the structure of an atom.**

- [ ]
- [ ]
- [ ]

### 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 9.1 The Covalent Bond

**Main Idea**

**Details**

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

1. 
2. 
3. 

**New Vocabulary**

*Use your text to define each term.*

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>covalent bond</td>
<td></td>
</tr>
<tr>
<td>molecule</td>
<td></td>
</tr>
<tr>
<td>Lewis structure</td>
<td></td>
</tr>
<tr>
<td>sigma bond</td>
<td></td>
</tr>
<tr>
<td>pi bond</td>
<td></td>
</tr>
<tr>
<td>endothermic</td>
<td></td>
</tr>
<tr>
<td>exothermic</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>stable</td>
<td></td>
</tr>
</tbody>
</table>
Main Idea

Why do atoms bond?
Use with page 241.

What is a covalent bond?
Use with page 242.

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 9-1 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, Cl:
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.

\[
\begin{align*}
H & \quad \text{Cl} \\
\vdots & \quad \vdots \\
\text{H} & \quad \text{Cl}
\end{align*}
\]

\[
\begin{align*}
\text{H} & \quad \text{Cl} \\
\vdots & \quad \vdots \\
\vdots & \quad \vdots
\end{align*}
\]

\[
\begin{align*}
\text{H} & \quad \text{Cl} \\
\vdots & \quad \vdots \\
\vdots & \quad \vdots
\end{align*}
\]
Main Idea

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).

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

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 9.2 Naming Molecules

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.
- 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. 

New Vocabulary
oxyacid

Use your text to define the following term.

Academic Vocabulary
formula

Define the following term.
Section 9.2 Naming Molecules (continued)

**Main Idea**

Identify the prefixes for these three binary molecular compounds.

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

**Details**

**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 9.2 Naming Molecules (continued)

**Main Idea**  

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

**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
- HC₅O  
  acetic acid
- HMnO₄  
  carbonic acid

**Writing Formulas from Names**  
*Use with pages 250–251.*

**Write** the chemical formula for the molecular compound names given below. Use the flow chart in Figure 9-9 to help you determine the correct formulas.

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

**SYNTHESESIZE**

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 9.3 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

Academic Vocabulary

Define the following term.

bond
Section 9.3 Molecular Structures (continued)

**Main Idea**

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

1. 
2. 
3. 
4. 

**Details**

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

1. 
2. 
3. 
4. 

**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.

   \[ \text{valence electrons/C atom} + \text{valence electrons/F atom} + \text{valence electrons/O atom} \]

   \[ = \text{valence electrons} \]

   \[ \text{available valence electrons/(2 electrons/pair)} = \text{available pairs} \]
Section 9.3 Molecular Structures (continued)

Main Idea

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 _______.

___ available pairs – ___ pairs used = 0

Carbon does not have an octet, so one of the lone pairs on the _______ atom must be used to form a _______ bond.

3. Evaluate the Answer

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

Solve Read Example Problem 9-5 in your text.

You Try It

- Problem

Draw the Lewis structure for the permanganate ion (MnO₄⁻).

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 Mn atom × ( valence electrons/Mn atom) + O atoms

× (6 valence electrons/O atom + electron(s) from the negative charge = valence electrons
Section 9.3 Molecular Structures (continued)

Main Idea

1. Evaluate the Answer
   All atoms now have an octet, and the group of atoms has a net charge of ___.

Details

Resonance Structures
Use with page 256.

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. __________________________________________

Exceptions to the Octet Rule
Use with pages 256–257.
Covalent Bonding
Section 9.4 Molecular Shape

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
Section 9.4 Molecular Shape (continued)

**VSEPR Model**
*Use with pages 259–260.*

**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 page 261.*

**Label the hybrid orbitals in the figures below as sp, sp², sp³, sp³d, or sp³d².**

Covalent Bonding 119
Finding the Shape of a Molecule

Use with Example Problem 9-7, page 262.

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: SbI₅
   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 × ( valence electrons/Sb atom) + I atoms × ( valence electrons/I atom) = valence electrons

   Three electron pairs exist on each iodine atom. This leaves ____ available valence electrons for bonding. ____ available valence electrons/(2 electrons/pair) = ____ 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 9.5 Electronegativity and Polarity

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

Use your text to define the following term.

polar covalent

Define the following term.

network
**Main Idea**

Electronegativity Difference and Bond Character

*Use with page 263.*

**Details**

Sequence the following elements from the least electronegative to the most electronegative. Use Table 9-15 for reference.

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

Polar Covalent Bonds

*Use with pages 264–265.*

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 9.5 Electronegativity and Polarity (continued)

**Main Idea**

Properties of Covalent Compounds

*Use with page 266.*

**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 (SiO₂) molecules is like, and how it has a tetrahedral structure similar to diamond structure.
Covalent Bonding  Chapter Wrap-Up

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

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ionic compound</td>
<td></td>
</tr>
<tr>
<td>molecular compound</td>
<td></td>
</tr>
</tbody>
</table>

### Chapter 8

**Explain how to write formulas for ionic compounds.**

### Chapter 9

**Explain how to write formulas for molecular compounds.**

**Write the formula for the following ionic compound.**
- aluminum carbonate

**Write the formula for the following molecular compound.**
- sulfuric acid
Chemical Reactions
Section 10.1 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
Evidence of Chemical Reactions

Use with page 277.

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 278–280.

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) ________________________________
**Main Idea**

**Balancing Chemical Equations**

*Use with pages 280–283.*

**Details**

**Solve** *Read Example Problem 10-1 in your text.***

**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 10.2 Classifying Chemical Reactions

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

synthesis reaction

combustion reaction

decomposition reaction

single-replacement reaction

double-replacement reaction

precipitate

Use your text to define each term.
Complete the following diagrams illustrating each classification of chemical reaction. The first one has been completed for you.

**Synthesis reactions**
*Use with page 284.*

**Combustion reactions**
*Use with page 285.*

**Decomposition reactions**
*Use with page 286.*

**Replacement reactions**
*Use with pages 287–291.*

**Main Idea**

**Details**

---

**Synthesis reaction**

- Substance → New compound

**Combustion reactions**

- Metal, nonmetal, or compound substance → 

**Decomposition reactions**

- Compound → Element or Element or

**Single-replacement reactions**

- Compound → Metal or nonmetal

**Double-replacement reactions**

- Compound with anion → 

---

Section 10.2 Classifying Chemical Reactions (continued)
**Section 10.2 Classifying Chemical Reactions** (continued)

**Main Idea**

Use with pages 284–291.

**Details**

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 10-10. 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. 

5. 

6. 

---

Chemical Reactions  131
Consider the title and first paragraph in Section 3. Based on what you read, what do you expect to learn in this chapter?

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

Define the following terms.

react
detect
obvious
Aqueous Solutions
Use with page 292.

Reactions That Form Precipitates
Use with pages 292–294.

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 295.

**Reactions That Form Gases**

Use with page 299.

### 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 10-13.

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

---

134  *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>
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.

______________________________

______________________________

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.

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?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
The Mole

Before You Read

**Review Vocabulary**

- atomic mass
- atomic mass unit (amu)

**Chapter 2**

*Define the following terms.*

- __________________________
  - __________________________

*Write the following in scientific notation*

- 0.005 82
- 24 367
- 400

*Circle the significant figures in the numbers below.*

- 75 600 000
- 0.000 33
- 3.140
The Mole
Section 11.1 Measuring Matter

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. ________________________________

Use your text to define each term.

Mole
______________________________

Avogadro’s number
______________________________

List three common counting units and their values.
1. ________________________________
2. ________________________________
3. ________________________________

New Vocabulary

Counting Particles
Use with page 309.
Section 11.1 Measuring Matter (continued)

Main Idea

Use with page 310.

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.

Converting Moles to Particles and Particles to Moles

Use with page 311.

The Mole
Section 11.1 Measuring Matter (continued)

Main Idea

Converting Number of Representative Particles to Moles

Details

Summarize Fill in the blanks to help you take notes as you read Example Problem 11–1.

- 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 $\times$

     = number of moles

     = ________

  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 11.2 Mass and the Mole

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 313–314.

Using Molar Mass

Use with pages 314–317.

**Main Idea**

**Details**

**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.

**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**: \( \text{atoms} \times \frac{1 \text{ mole}}{6.02 \times 10^{23}} \)
  \[ \text{moles} \times \frac{\text{number of grams}}{1 \text{ mole}} \]
**Main Idea**

**Using Molar Mass**

**Mass to Atoms Conversion**

*Use with Example Problem 11-4, page 317.*

**Details**

**Problem**

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

1. **Analyze the Problem**
   
   Known:  \( \text{mass} = \) 10 \( \text{g} \) of \( \text{Cu} \)
   
   Unknown:  \( \text{molar mass} \), number of atoms

2. **Solve for the Unknown**

   Use the periodic table to find the atomic mass of copper and convert it to \( \text{g/mol} \).

   Complete the conversion equations.

   \[
   \text{mass Cu} \times \text{conversion factor} = \text{moles Cu}
   \]

   \[
   \text{mol Cu} \times \text{conversion factor} = \text{atoms Cu}
   \]

3. **Evaluate the Answer**

   Restate the answer with correct significant digits.
The Mole
Section 11.3 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 page 320.

Mole Relationships from a Chemical Formula
Use with Example Problem 11-6, page 321.

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

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 11.3 Moles of Compounds (continued)

Main Idea

The Molar Mass of Compounds

Use with page 322.

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></td>
<td>g</td>
</tr>
</tbody>
</table>

Converting Moles of a Compound to Mass

Use with page 323.

Analyze the process of converting moles of a compound to molar mass by completing the table below. Refer to Example Problem 11-7.

<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></td>
<td>g</td>
</tr>
</tbody>
</table>
Section 11.3 Moles of Compounds (continued)

**Main Idea**

Converting the Mass of a Compound to Moles

*Use with page 324.*

**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 Ca(OH)₂ x conversion factor = mol Ca(OH)₂

_____ × _____ / ________ = ___ mol Ca(OH)₂

**Converting the Mass of a Compound to Number of Particles**

*Use with page 325.*

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.
The Mole
Section 11.4 Empirical and Molecular Formulas

Main Idea

Details

Skim Section 4 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.

percent composition

empirical formula

molecular formula

Academic Vocabulary

Define the following terms.

stable

environment
Percent Composition
Use with pages 328–329.

Empirical Formula
Use with pages 331–332.

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 11.4  Empirical and Molecular Formulas (continued)

**Main Idea**

**Molecular Formula**

*Use with pages 333–335.*

**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 11-12 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>g C/mol C</td>
<td>=</td>
<td>g C</td>
</tr>
<tr>
<td>3 mol H</td>
<td>g H/mol H</td>
<td>=</td>
<td>g H</td>
</tr>
<tr>
<td>2 mol O</td>
<td>g O/mol O/ mol C/mol</td>
<td>=</td>
<td>g O</td>
</tr>
</tbody>
</table>

Empirical molar mass of \( \text{C}_2\text{H}_3\text{O}_2 \) = g

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

\[
n = \frac{\text{molar mass of substance}}{\text{molar mass of compound}} = \]

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.

- Percent composition
- Mass of component elements
  - Mass of each element
    - Molar mass
  - Ratio of moles of elements
    - If all are whole numbers
    - If not all whole numbers, multiply by the smallest factor that will produce whole numbers
  - Empirical formula
    - Experimental molar mass
      - Mass of empirical formula
        - (Empirical formula) $n$
          - Molecular formula
Skim Section 5 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 the following term.

New Vocabulary

hydrate

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 11.5 The Formula for a Hydrate (continued)

Main Idea

Analyzing a Hydrate
Use with page 339.

Determining the Formula for a Hydrate
Use with Example Problem 11-14, page 340.

Details

Describe an anyhydrate.

Solve Read Example Problem 11-14 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 • 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 H₂O and anhydrous BaCl₂ using the conversion factor that relates moles and mass based on the molar mass.

\[
\frac{4.26 \text{ g } \text{BaCl}_2}{0.84 \text{ g } \text{H}_2\text{O}} \times \frac{\text{moles of } \text{H}_2\text{O}}{\text{moles } \frac{\text{H}_2\text{O}}{\text{BaCl}_2}} = \frac{\text{moles } \text{H}_2\text{O}}{\text{moles } \text{BaCl}_2}
\]

Determine the value of x.

\[
x = \frac{\text{moles } \text{H}_2\text{O}}{\text{moles } \text{BaCl}_2} = \quad = \quad
\]

3. Evaluate the Answer

The ratio of H₂O to BaCl₂ 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  Chapter Wrap-Up

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

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

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

Before You Read

Review Vocabulary

Define the following terms.

mole

molar mass

conversion factor

dimensional analysis

law of conservation of mass

Balance the following equation.

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

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 12.1 What is Stoichiometry?

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.

stoichiometry

mole ratio

Academic Vocabulary

Define the following term.

qualitative

Mole-Mass Relationships in Chemical Reactions

Use with page 354.

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

Use with page 354.
**Interpreting Chemical Equations**

*Use with Example Problem 12-1, page 354.*

**Main Idea**

**Details**

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

**Problem**

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

1. **Analyze the Problem**

   Known: ____________________________

   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.

   moles of reactant \( \times \frac{\text{grams of reactant}}{1 \text{ mole of reactant}} = \text{grams of ______} \)

   moles of product \( \times \frac{\text{grams of reactant}}{1 \text{ mole of reactant}} = \text{grams of ______} \)

   Add the masses of the reactants.

   \[ \boxed{\text{g C}_3\text{H}_8 + \boxed{\text{g O}_2} = \boxed{\text{g reactants}} \]

   Add the masses of the products.

   \[ \boxed{\text{g CO}_2 + \boxed{\text{g H}_2\text{O}} = \boxed{\text{g products}} \]

   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 __________ significant figures. Your answer must have __________ significant figures.
**Main Idea**

Mole ratios

*Use with page 356.*

**Details**

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

**Example**

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

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 12.2 Stoichiometric Calculations

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. ________________________________________

Define the following terms.
convert
__________________________________________
process
__________________________________________
significant
__________________________________________

Identify the tools needed for stoichiometric calculations.
All stoichiometric calculations start with __________ based on a _________________. Finally, ____________________ are required.
Main Idea

Stoichiometric Mole-to-Mole Conversion

Use with Example Problem 12-2, page 359.

Details

Solve Read Example Problem 12-2 in your text.

You Try It

Problem

How many moles of aluminum oxide (Al₂O₃) are produced when 4.0 moles of aluminum (Al) are combined with oxygen gas (O₂)?

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.

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

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 Al₂O₃.

Multiply the known number of moles Al by the mole ratio to find the moles of unknown Al₂O₃.

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

3. Evaluate the Answer

The given number of moles has significant figures. Therefore, the answer must have significant figures.
Main Idea

Stoichiometric Mole-to-Mass Conversion

Use with Example Problem 12-3, page 360.

Details

Solve

Read Example Problem 12-3 in your text.

You Try It

Problem

How many grams of solid iron (III) chloride (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.

Fe(s) + Cl₂(g) → FeCl₃(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.

\[ \text{mol Fe} \times \frac{\text{mol FeCl₃}}{\text{mol Fe}} = \text{mol FeCl₃} \]

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

\[ \text{mol FeCl₃} \times \frac{\text{g FeCl₃}}{1 \text{ mol FeCl₃}} = \text{g FeCl₃} \]

3. Evaluate the Answer

The given number of moles has digits, so the mass of FeCl₃ must have digits.
Section 12.2 Stoichiometric Calculations (continued)

### Main Idea

**Stoichiometric Mass-to-Mass Conversion**

*Use with Example Problem 124, page 361.*

### Details

**Solve** Read Example Problem 12-4 in your text.

**You Try It**

- **Problem**
  
  Determine the mass of ammonia (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.

   \[ \text{N}_2(g) + 3 \text{H}_2(g) \rightarrow 2 \text{NH}_3(g) \]

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

   \[ \frac{\text{g N}_2}{\text{mol N}_2} \times \frac{1 \text{ mol N}_2}{\text{g N}_2} = \frac{\text{mol N}_2}{\text{g N}_2} \]

   List the mole ratios for this equation.

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

   \[ \frac{\text{mol N}_2}{\text{mol NH}_3} = \frac{\text{mol NH}_3}{\text{mol N}_2} \]

   Multiply moles of NH₃ by the molar mass.

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

3. **Evaluate the Answer**

   The given mass has \text{significant figures}, so the mass of NH₃ must have \text{significant figures}.
Section 12.2 Stoichiometric Calculations (continued)

**Main Idea**

**Details**

Steps in Stoichiometric Calculations

*Use with page 363.*

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

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.

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

1. Interpret the equation in terms of _____.
2. Use the _____ as the conversion factor.
3. Use the appropriate mole ratio from the _____ as the conversion factor.
4. Use _____ as the conversion factor.
Stoichiometry
Section 12.3 Limiting Reactants

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

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

Write three facts you discovered about limiting reactants.

1. __________________________
2. __________________________
3. __________________________

New Vocabulary

limiting reactant
Definition: __________________________

excess reactant
Definition: __________________________

Academic Vocabulary

reassemble
Definition: __________________________
Section 12.3 Limiting Reactants (continued)

**Main Idea**

Why do reactions stop?

*Use with page 364.*

**Details**

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

**Organize** information about limiting reactants.

I. ______________

A. Limiting reactant
   1. ______________
   2. ______________

B. ______________

II. Calculating the product when a reactant is limited

A. ______________
   1. convert the masses to moles
   2. multiply each mass by the inverse of the molar mass

B. ______________

C. ______________

D. Determine the amount of product that can be made with the moles of the limiting reactant.

**Solve** Read Example Problem 12-5 in your text.

**You Try It**

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

1. **Analyze the Problem**
   
   Known: ________________
   
   Unknown: ________________

2. **Solve for the Unknown**
   
   Write the balanced chemical equation.
Section 12.3 Limiting Reactants (continued)

(List the mole ratios for this equation.

Multiply each mass by the inverse of molar mass.

Calculate the actual ratio of available moles.

Determine the limiting reactant.

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

Multiply moles of the product by the molar mass.

Multiply moles of the excess reactant by the molar mass.

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

3. Evaluate the Answer

The given mass has ______ significant figures, so the mass of the unknown must have ______ significant figures.
Stoichiometry
Section 12.4 Percent Yield

Main Idea

Details

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

In the left margin, write the terms defined below.

- the ratio of actual yield to theoretical yield (from stoichiometric calculations) expressed as a percent
- in a chemical reaction, the maximum amount of product that can be produced from a given amount of reactant
- the amount of product actually produced when a chemical reaction is carried out in an experiment

Define the following term.

maximize

Write the formula for percent yield.

\[ \text{percent yield} = \frac{\text{actual yield (from an experiment)}}{\text{theoretical yield (from stoichiometric calculations)}} \times 100 \]
Section 12.4 Percent Yield (continued)

Main Idea

Calculating Percent Yield

Use with page 371.

Details

Solve

Read Example Problem 12-6 in your text.

You Try It

Problem

When 100.0 kg sand (\(\text{SiO}_2\)) 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 \(\text{SiO}_2\) to \(\text{SiC}\).

   Convert kg to g.

   \(100 \text{ kg } \text{SiO}_2 = \underline{\phantom{0}} \text{ g}, \ 51.4 \text{ kg } \text{SiC} = \underline{\phantom{0}} \text{ g}\)

   Convert mass to moles using the inverse of molar mass.

   Use the appropriate mole ratio to convert mol \(\text{SiO}_2\) to mol \(\text{SiC}\).

   Calculate the theoretical yield. Multiply mol \(\text{SiC}\) by the molar mass.

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

3. Evaluate the Answer

   The quantities have \(\boxed{\phantom{0}}\) significant figures, so the percent yield must have \(\boxed{\phantom{0}}\) significant figures.
In the left margin, write the stoichiometry concepts that parallel the daily activities of a Wall Street professional.

<table>
<thead>
<tr>
<th>Stoichiometry and the Stock Market</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.</strong> A stock analyst keeps a close eye on the earnings of corporations. She has determined how much each company should accomplish.</td>
</tr>
<tr>
<td><strong>2.</strong> The same analyst tracks whether companies meet expectations or fall short.</td>
</tr>
<tr>
<td><strong>3.</strong> 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.</td>
</tr>
<tr>
<td><strong>4.</strong> 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.</td>
</tr>
<tr>
<td><strong>5.</strong> 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.</td>
</tr>
</tbody>
</table>
Now that you have read the chapter, review what you have learned. Write the key equations and relationships.

Use this checklist to help you study.

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

REAL-WORLD CONNECTION

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 13.1 Gases

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.
The Kinetic-Molecular Theory
Use with pages 385–386.

Explaining the Behavior of Gases
Use with pages 386–387.

Main Idea

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 = (1/2mv^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 173
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.

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 or lb/in^2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>atmosphere (atm)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
States of Matter
Section 13.2 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.

distribute


Section 13.2 Forces of Attraction (continued)

Main Idea

Intermolecular Forces

Use with pages 393–395.

Details

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 13.3 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

viscosity

surface tension

surfactant

crystalline solid

unit cell

amorphous solid

Academic Vocabulary

predict

Use your text to define each term.

Define the following term.
Liquids

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>
**Section 13.3 Liquids and Solids** (continued)

**Main Idea**

**Details**

**Explain** *surface tension* by completing the web diagram below.

- The energy required to increase the ____________
- A measure of the ____________ by interior particles
- The stronger the ____________ between particles, the ____________ the surface tension
- The surface tension of water is ____________ because its molecules form ____________

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

Capillary action is ________________________________
______________________________

Cohesion is ________________________________

Adhesion is ________________________________
**Main Idea** — **Details**

**Solids**

*Use with pages 399–400.*

**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 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 13.4 Phase Changes

Main Idea

Details

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

New Vocabulary

Use your text to define each term.

- sublimation
- condensation
- deposition
- phase diagram

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

- melting point, freezing point, and triple point
- vaporization and evaporation
Phase Changes that Require Energy

Classify the types of phase changes by completing the table below. Use Figure 13–22 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></td>
</tr>
<tr>
<td>solid to gas</td>
<td>condensation</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 13.4 Phase Changes (continued)

Main Idea

Phase Changes That Release Energy

Use with pages 407–408.

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>sublimation</td>
<td></td>
</tr>
</tbody>
</table>

Phase Diagrams

Use with pages 408–409.

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 13–28 in your text for reference.
States of Matter  Chapter Wrap-Up

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
Define the following terms.

- **density**
- **stoichiometry**
- **kinetic-molecular theory**

Balance the following equation.

\[
\begin{align*}
\_\text{Fe} + \_\text{H}_2\text{SO}_4 & \rightarrow \text{Fe}_2(\text{SO}_4)_3 + \_\text{H}_2 \\
\end{align*}
\]

Chapter 12

Show the mole ratios for the following reaction.

\[
\begin{align*}
\text{N}_2 + 3\text{H}_2 & \rightarrow 2\text{NH}_3 \\
\end{align*}
\]

- **a.** mole ratio of N to H\(_2\)
- **b.** mole ratio of NH\(_3\) to H\(_2\)

Chapter 13

Explain how gas particles exert pressure.
Gases
Section 14.1 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

Charles’s law

Gay-Lussac’s law

Academic Vocabulary

Define the following term.

theory
Section 14.1 The Gas Laws (continued)

**Main Idea**

**Kinetic Theory**
*Use with pages 419–420.*

List the five assumptions the kinetic theory makes about gases.
1. 
2. 
3. 
4. 
5. 

**Boyle’s Law**
*Use with Example Problem 14-1, page 422.*

**Summarize** Fill in the blanks to help you take notes while you read Example Problem 14-1.

**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:
   - \( V_1 = \) _______ \( P_2 \) _______
   - \( V_2 = \) _______
   - \( P_1 = \) _______
   - Use the equation for Boyle’s law to solve for \( P_2 \).

2. **Solve for the Unknown**
   - Write the equation for Boyle’s law: \( \) _______
   - To solve for \( P_2 \), divide both sides by \( V_2 \). \( P_2 = \) _______
   - Substitute the known values. \( P_2 = \) _______
   - Solve for \( P_2 \). \( P_2 = \) _______

3. **Evaluate the Answer**
   - When the volume is _______, the pressure is _______.
   - The answer is in _____, a unit of pressure.
Summarize Fill in the blanks to help you take notes while you read Example Problem 14-2.

### Problem
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:**
     - $T_1 = ____$
     - $V_1 = ____$
     - $T_2 = ____$
   - **Unknown:**
     - $V_2 = ____$

   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:
     - $T_1 = 273 + 40.0°C = ____ K$
     - $T_2 = 273 + 75.0°C = ____ K$

   Write the equation for Charles’s law:

   $\text{To solve for } V_2, \text{ multiply both sides by } T_2:

   V_2 = \ldots$

   Substitute known values:

   $V_2 = \ldots$

   Solve for $V_2$.

   $V_2 = \ldots$

3. **Evaluate the Answer**

When temperature in kelvin increases by a small amount, the volume increases by a small amount. The answer is in ____, a unit for volume.
Section 14.1 The Gas Laws (continued)

**Main Idea**

**Gay-Lussac’s Law**

*Use with Example Problem 14-3, page 426.*

**Details**

**Solve** Read Example Problem 14-3 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:  
\[ P_1 = 4.0 \text{ atm} \]
\[ T_1 \]  
Unknown:  
\[ P_2 = ? \]
\[ T_2 \]

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.

\[ T_1 = ____ + 22.0^\circ \text{C} = ____ \text{ K} \]
\[ T_2 = 273 + ____ ^\circ \text{C} = ____ \text{ K} \]

Write the equation for Gay-Lussac’s law.

\[ \frac{P_1}{T_1} = \frac{P_2}{T_2} \]

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 ________.
Gases

Section 14.2 The Combined Gas Law and Avogadro’s Principle

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.

combined gas law

Avogadro’s principle

molar volume

Academic Vocabulary

Define the following term.

convert
Section 14.2 The Combined Gas Law and Avogadro’s Principle (continued)

**Main Idea**

**The Combined Gas Law**

*Use with page 428.*

**Details**

**Describe** the combined gas law.

**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:**
   
   \[ P_1 = \text{_______} \]
   
   \[ T_1 = \text{_______} \]
   
   \[ V_1 = \text{_______} \]
   
   **Unknown:**
   
   \[ T_2 = ? \degree C \]
   
   \[ P_2 = \text{_______} \]
   
   \[ V_2 = \text{_______} \]

   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.

   \[ T_1 = \text{_______} + 30.0\degree C = \text{_______} K \]
Section 14.2 The Combined Gas Law and Avogadro’s Principle (continued)

Main Idea

Write the combined gas law equation.

\[
\frac{T_1}{T_2} = \frac{P_2 V_2}{P_1 V_1}
\]

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

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

\[ T_2 P_1 V_1 = \]

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

\[ T_2 = \]

Substitute known values.

\[ T_2 = \frac{100.0 \text{ kPa} \times 1.00 \text{ L}}{273K - 30.0^\circ \text{C}} \]

Solve for \( T_2 \).

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

3. Evaluate the Answer

As pressure _______ and volume _______ in proportional amounts, the temperature remained constant.

Avogadro’s Principle

Use with pages 430–431.

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 _____.
Section 14.3 The Ideal Gas Law

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 the ideal gas law.

1. _______________________________________
2. _______________________________________
3. _______________________________________

Use your text to define each term.

ideal gas constant \( (R) \)

Define the following term.

volume
The Ideal Gas Law

Use with pages 434–435.

**Main Idea**

**The Ideal Gas Law**

*Analyze the ideal gas law.*

The equation is written \( \_ \_ = \_ \_ \)

- \( P \) 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–Using Moles

Use with Example Problem 14-7, pages 436–437.

**Section 14.3 The Ideal Gas Law** (continued)

**Main Idea**

**Details**

**Summarize** Fill in the blanks to help you take notes while you read Example Problem 14-7.

**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:**
   
   - $n = ? \text{ mol}$

   Use the known values to find the value of $n$.

2. **Solve for the Unknown**
   
   Write the ideal gas law equation.
   
   $\frac{n}{V} = \frac{P}{RT}$
   
   To solve for $n$, divide both sides by $RT$.
   
   $n = \_\_\_\_$

   Substitute known values into the equation.
   
   $n = \_\_\_\_$

   Solve for $n$.
   
   $n = \_\_\_\_$

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 _______.
Scan Section 4 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.

react

involve

affect

proportion
Indicate the moles and volume for the reaction below. Use Figure 14-12 as a reference.

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

__ moles  __ moles  __ moles  __ moles

__ volume  __ volumes  __ volumes  __ volumes

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 14-9.

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: Unknown:

\[ V \text{ of } C_3H_8 = \text{____} \quad V \text{ of } O_2 = \text{? L} \]

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 C₃H₈.

\[ \text{______________________________} \]

Write the volume ratio.

Multiply the known volume of propane by the volume ratio to find the volume of O₂.

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.
# Solutions

## Before You Read

<table>
<thead>
<tr>
<th>Review Vocabulary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Define the following terms.</strong></td>
</tr>
<tr>
<td><strong>alloy</strong></td>
</tr>
<tr>
<td><strong>solution</strong></td>
</tr>
</tbody>
</table>

### Chapter 3

**Compare and contrast** a **homogeneous mixture** with a **heterogeneous mixture**.

### Chapter 9

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

### Chapter 11

**Describe** the relationship between moles and molar mass.
Solutions
Section 15.1 What are solutions?

Main Idea

Details

Skim Section 1 of your text. List three main ideas of the section.
1. ______________________________
2. ______________________________
3. ______________________________

New Vocabulary

Use your text to define each term.
solvation
heat of solution
solubility
supersaturated solution
Henry's law

Compare and contrast soluble and insoluble substances.

Compare and contrast miscible and immiscible liquids.

Compare and contrast saturated solutions and unsaturated solutions.
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. When two liquids are not soluble in each other, they are said to be ________. Liquids that will dissolve in each other are said to be ________.

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 15.1 What are solutions? (continued)

**Main Idea**

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 into smaller pieces</td>
<td></td>
</tr>
<tr>
<td>increasing temperature of the solvent</td>
<td></td>
</tr>
</tbody>
</table>

**Details**

Explain how solubility is expressed in units of measurement.

Review Table 15-2 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 15.1  What are solutions? (continued)

**Main Idea**

Factors That Affect Solubility
*Use with pages 458–461.*

**Details**

**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.

**Using Henry’s Law**
*Use with Example Problem 15-1, page 461.*

**Problem** Fill in the blanks to help you take notes while you read Example Problem 15-1.

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.
## Solutions

### Section 15.2 Solution Concentration

#### Main Idea

**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. ______________________________________________________________________

#### Details

**New Vocabulary**  
*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>

**Academic Vocabulary**  
*Define the following term.*

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>factor</td>
<td>__________</td>
</tr>
</tbody>
</table>
Main Idea

Expressing Concentration
Use with page 462.

Using Percent to Describe Concentration
Use with page 463.

Calculating Percent by Mass
Use with Example Problem 15–2, page 463.

Details

Analyze the similarities in all of the concentration ratios shown in Table 15-3 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 15-2.

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: 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.
Section 15.2 Solution Concentration (continued)

Molarity

Preparing Molar Solutions
Use with pages 466–467.

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.

__________________________________________

$M_1$ = __________________________

$V_1$ = __________________________

$M_2$ = __________________________

$V_2$ = __________________________
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.

$X_A = \frac{n_A}{M}$

$X_B = \frac{n_B}{M}$

Evaluate the mole fraction for the values given in problem 15-5 on page 469 of your text. The number of moles for 100 g H$_2$O is given.

$n_A = 5.55$ mol H$_2$O

$n_B = _____$ mol NaCl

$X_{H_2O} = \frac{n_{H_2O}}{n_{H_2O} + n_{NaCl}} = _____$

$X_{NaCl} = \frac{n_{NaCl}}{n_{H_2O} + n_{NaCl}} = _____$

$X_{H_2O} + X_{NaCl} = 1.000$

_____ + _____ = 1.000

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

Section 15.3 Colligative Properties of Solutions

Scan Section 3 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
Section 15.3 Colligative Properties of Solutions (continued)

**Main Idea**

**Electrolytes and Colligative Properties**

Use with page 471.

**Details**

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.

Boiling Point Elevation

Use with page 472.

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 15.3 Colligative Properties of Solutions (continued)

**Main Idea**

**Freezing Point Depression**

Use with pages 473–474.

**Details**

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

... (space for student response)

... (space for student response)

... (space for student response)

... (space for student response)

**Osmosis and Osmotic Pressure**

Use with page 475.

**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.

![Diagram of a semipermeable membrane separating a sucrose-water solution on one side and water on the other side.](image)
# Solutions

Section 15.4 Heterogeneous Mixtures

**Main Idea**

**Details**

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.

**Identify** the unifying theme of this section.

---

**New Vocabulary**

*Use your text to define each term.*

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>suspension</td>
<td></td>
</tr>
<tr>
<td>colloid</td>
<td></td>
</tr>
<tr>
<td>Brownian motion</td>
<td></td>
</tr>
<tr>
<td>Tyndall effect</td>
<td></td>
</tr>
</tbody>
</table>

**Academic Vocabulary**

*Define the following terms.*

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>abundant</td>
<td></td>
</tr>
<tr>
<td>categorize</td>
<td></td>
</tr>
</tbody>
</table>
Suspensions
Use with page 476.

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. __________________________
**Main Idea**

**Details**

**Explain** why particles in Brownian motion do not settle out.

---

**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.

---
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.

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

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.
Energy and Chemical Change

Before You Read

**Review Vocabulary**

*Define the following terms.*

- chemical equation
  - 
  - 
  -

- mole
  - 
  - 
  -

**Chapter 11**

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

**Chapter 13**

*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 16.1 Energy

Main Idea

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

1. 

2. 

Details

New Vocabulary

Use your text to define each term.

energy

law of conservation of energy

chemical potential energy

heat

calorie

joule

specific heat
Section 16.1 Energy (continued)

**Main Idea**

**The Nature of Energy**

*Use with pages 489–491.*

**Details**

**Compare and contrast** kinetic energy with potential energy.

On the curve below that represents the roller coaster on page 488, label the place of greatest kinetic energy A, least kinetic energy B, greatest potential energy C, and least potential energy D.

Describe the roller coaster ride above as a function of the law of conservation of energy.

**Specific Heat**

*Use with pages 492–493.*

Identify each symbol in the equation for specific heat.

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

- \( q \) represents heat absorbed or released
- \( c \) represents the specific heat of the substance
- \( m \) represents mass of a sample in grams
- \( \Delta T \) represents a change in temperature

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.
Section 16.1 Energy (continued)

### Main Idea

**Calculating Specific Heat**

*Use with Example Problem 16–2, page 494.*

### Details

**Summarize.** *Fill in the blanks to help you take notes while you read Example Problem 16–2.*

- **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 = ____ specific heat of iron = ?

  \( \Delta T = \) __________

  mass of iron = ____

- **2. Solve for the Unknown**

  Write the equation for heat absorption.

  \[
  q = \]

  Solve for \( c \).

  \[
  q = \quad c = \]

  \[
  c = \]

- **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 16–2.

### 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 16.2 Heat in Chemical Reactions and Processes

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

Academic Vocabulary

Define the following term.

utilize
Section 16.2 Heat in Chemical Reactions and Processes (continued)

**Main Idea**

**Measuring Heat**

*Use with page 496.*

**Details**

Describe *how a calorimeter measures heat.*

---

**Using Data from Calorimetry**

*Use with Example Problem 16–3, pages 497–498.*

**Summarize.** Fill in the blanks to help you take notes while you read Example Problem 16–3.

**Problem**

Determine the specific heat of a piece of metal with a mass of 4.68 g that ______ 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.
   
   $q = \ldots$
   
   Solve for $c$ by dividing both sides of the equation by $m \times ΔT$.
   
   $c =$
Chemical Energy and the Universe
Use with pages 498–500.

Compare and contrast exothermic and endothermic reactions.

Write the symbol for enthalpy (heat) chain 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 16.3 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.

__________________________________________________________________________________
__________________________________________________________________________________
__________________________________________________________________________________

Details

**New Vocabulary**

Use your text to define each term.

**thermochemical equation**

__________________________________________________________________________________

**enthalpy (heat) of combustion**

__________________________________________________________________________________

**molar enthalpy (heat) of vaporization**

__________________________________________________________________________________

**molar enthalpy (heat) of fusion**

__________________________________________________________________________________

**Academic Vocabulary**

Define the following term.

**region**

__________________________________________________________________________________
Section 16.3 Thermochemical Equations (continued)

**Main Idea**

**Writing Thermochemical Equations**

*Use with page 501.*

**Details**

**Identify which of the reactions below is endothermic and explain how you know.**

1. \(4\text{Fe}(s) + 3\text{O}_2(g) \rightarrow 2\text{Fe}_2\text{O}_3(s)\)
   \[\Delta H = -1625 \text{ kJ}\]

2. \(\text{NH}_4\text{NO}_3(s) \rightarrow \text{NH}_4^+(aq) + \text{NO}_3^-(aq)\)
   \[\Delta H = 27 \text{ kJ}\]

**Identify which of the reactions below is exothermic and explain how you know.**

1. \(4\text{Fe}(s) + 3\text{O}_2(g) \rightarrow 2\text{Fe}_2\text{O}_3(s)\)
   \[\Delta H = -1625 \text{ kJ}\]

2. \(\text{NH}_4\text{NO}_3(s) \rightarrow \text{NH}_4^+(aq) + \text{NO}_3^-(aq)\)
   \[\Delta H = 27 \text{ kJ}\]

**Changes of State**

*Use with page 502.*

**Name the common states of matter.**
Section 16.3 Thermochemical Equations (continued)

**Main Idea**

**Details**

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.

**Identify** what the following equations represent.

\[ \Delta H_{\text{vap}} = -\Delta H_{\text{cond}} \]

\[ \Delta H_{\text{fus}} = -\Delta H_{\text{solid}} \]

**REAL-WORLD CONNECTION**

Explain why a farmer would spray his orange trees with water when he knows the overnight temperature will be below 32°C.
Energy and Chemical Change

Section 16.4 Calculating Enthalpy Change

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

Academic Vocabulary

random

Use your text to define each term.

Define the following term.
Section 16.4 Calculating Enthalpy Change (continued)

Hess’s Law
Use with pages 506–508.

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 16-13. 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 ΔHᵣ°, or _______________ ________________, of exactly ____. The ΔHᵣ° of many ________ has been measured __________. For example, the standard enthalpies of formation for the following compounds are:

NO₂(g) ___
CCl₄(l) ___
Fe₂O₃(s) ___
Section 16.4 Calculating Enthalpy Change (continued)

Write the formula that sums up the procedure for combining standard heats of formation equations to produce the desired equation and its $\Delta H_{\text{rxn}}^0$.

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 16–6.

Problem

Calculate $\Delta H_{\text{rxn}}^0$ 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 $\Delta H_{\text{rxn}}^0 = \Sigma \Delta H_f^0 (\text{products}) - \Sigma \Delta H_f^0 (\text{reactants})$ with data from Table 16-7.

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:

$\Delta H_{\text{rxn}}^0 =$ ? kJ
Section 16.4 Calculating Enthalpy Change (continued)

2. Solve for the Unknown
   Use the formula $\Delta H_{rxn}^0 = \Sigma \Delta H_f^0 \text{(products)} - \Sigma \Delta H_f^0 \text{(reactants)}$
   
   Substitute values in the formula
   $\Delta H_{rxn}^0 = \text{__________}$
   $\Delta H_{rxn}^0 = \text{__________} = \text{_______}$

3. Evaluate the Answer
   All values are ______ to the stated place. The calculated value matches that in Table 16–5.

**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. ____________________________
### Main Idea

**Energy and Chemical Change**

**Section 16.5 Reaction Spontaneity**

### Details

**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.

<table>
<thead>
<tr>
<th>New Vocabulary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use your text to define each term.</td>
</tr>
</tbody>
</table>

**spontaneous process**

**entropy**

**law of disorder**

**free energy**

**Academic Vocabulary**

**Define the following term.**

**intervention**
Section 16.5 Reaction Spontaneity (continued)

**Main Idea**

Spontaneous Processes

*Use with page 513.*

**Details**

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. ________________________________
Section 16.5 Reaction Spontaneity (continued)

**Main Idea**

**Entropy, the Universe, and Free Energy**

*Use with pages 516–518.*

**Details**

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.

\[ \text{N}_2(g) + 3\text{H}_2(g) \rightarrow 2\text{NH}_3(g) \]

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.

| How \( \Delta H^0_{\text{system}} \) and \( \Delta S^0_{\text{system}} \) Affect Reaction Spontaneity |
|---|---|
| \( -\Delta H^0_{\text{system}} \) | \( +\Delta H^0_{\text{system}} \) |
| \( +\Delta S^0_{\text{system}} \) | |
| \( -\Delta S^0_{\text{system}} \) | |
Chapter Wrap-Up

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**

<table>
<thead>
<tr>
<th>Review Vocabulary</th>
<th>Define the following terms.</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 10**

Balance the following equation.

$$\square C_8H_{18}(l) + \square O_2(g) \rightarrow \square CO_2(g) + \square H_2O(l)$$
Reaction Rates
Section 17.1 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

transition state

activation energy

Academic Vocabulary

Define the following term.

consumption
Main Idea

Expressing Reaction Rates
Use with page 529.

Calculating Average Reaction Rates
Use with Example Problem 17-1, page 531.

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 17-1.

Problem
Calculate the average reaction rate of the chemical reaction using the ____________ of butyl chloride in _________.

1. Analyze the Problem
Known:
Unknown:

__________________________

\( [C_4H_9Cl] \) at \( t_1 = 0.220M \)

__________________________

2. Solve for the Unknown
Write the equation.
Average reaction rate =
Insert known quantities.
Solve for the average rate =


Average reaction rate =

3. Evaluate the Answer
The answer is correctly expressed in _____ significant figures.
Describe how each of the items below affects a reaction.

**collision theory**

orientation and the activated complex

activation energy and reaction

**Analyze** Figure 17-3. 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.
Reaction Rates
Section 17.2 Factors Affecting Reaction Rates

Main Idea

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. 

New Vocabulary

Use your text to define each term.

catalyst

inhibitor

heterogeneous catalyst

homogeneous catalyst

Academic Vocabulary

Define the following term.

orientation

The Nature of Reactants

Use with page 536.

Explain how reactants influence the rate at which a chemical reaction occurs by completing the following statement.

As the reactant increases, the __________ increases.
Section 17.2 Factors Affecting Reaction Rates (continued)

Main Idea

Use with pages 536–539.

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 17.3 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

specific rate constant

reaction order

method of initial rates

Academic Vocabulary

Define the following term.

interval
Reaction Rate Laws

Use with pages 542–543.

Main Idea

Reaction Rate Laws

Details

Explain what each symbol represents in the following equation.
Rate = $k[A]$

$k = \ldots$

$[A] = \ldots$

Analyze the rate law reaction for the decomposition of hydrogen peroxide.

$2H_2O_2 \rightarrow 2H_2O + O_2$

Rate law equation: rate = $k[A]$, where $[A] = \ldots$

Insert the reactant: rate = \ldots

Express the rate law reaction for this chemical reaction.

Chemical equation: $2NO(g) + 2H_2(g) \rightarrow N_2(g) + 2H_2O(g)$

Rate law equation: rate = \ldots, where [A] represents the reactant \ldots and [B] represents the reactant \ldots

Insert the reactants: rate = \ldots
### Determining Reaction Order

*Use with pages 544–545.*

#### Main Idea

Relate *how the reaction rate varies with:*
- concentration

---

the overall reaction order

---

#### Details

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 17.4 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 17.4 Instantaneous Reaction Rates and Reaction Mechanisms (continued)

Calculating Instantaneous Reaction Rates

Use with Example Problem 17-2, page 547.

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: Unknown:
   quantity of \([\text{NO}]\) = 0.002 00 M 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.
   
   rate = 
   rate = 
   rate = 

3. Evaluate the Answer
   Are your units correct? Is your magnitude reasonable?

Compare the reaction mechanism using the terms complex, intermediate, rate-determining step to the process of building a car. Show that you understand the vocabulary.
Now that you have read the chapter, list three facts you learned about reaction rates:

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 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 10**

Balance the chemical equation below.

\[
\text{NO(g) + H}_2\text{(g) } \rightarrow \text{N}_2\text{O(g) + H}_2\text{O(g)}
\]

**Chapter 17**

Write the rate law for the reaction below.

\[
\text{H}_2\text{(g) + I}_2\text{(g) } \rightarrow 2 \text{ HI(g)}
\]

Rate = _______________
Chemical Equilibrium
Section 18.1 Equilibrium: A State of Dynamic Balance

Main Idea

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.

Details

New Vocabulary

Use your text to define each term.

reversible reaction

chemical equilibrium

law of chemical equilibrium

equilibrium constant

homogeneous equilibrium

heterogeneous equilibrium
Section 18.1 Equilibrium: A State of Dynamic Balance (continued)

**Main Idea**

What is Equilibrium?
*Use with pages 559–563.*

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.

\[ \text{N}_2(g) + 3\text{H}_2(g) \xleftrightarrow{\text{催化剂}} 2\text{NH}_3(g) \]

<table>
<thead>
<tr>
<th></th>
<th>Reactants</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward reaction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse reaction</td>
<td></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.

\[ K_{eq} = \frac{[C]^c[D]^d}{[A]^a[B]^b} \]

\[ K_{eq} = \frac{[C][D]}{[A][B]} = \frac{[C]^c[D]^d}{[A]^a[B]^b} = a, b, c, \text{ and } d = \]

Equilibrium Expressions and Constants
*Use with pages 563–566.*
Write the equilibrium constant expression for the following balanced chemical equation.

\[ \text{N}_2(g) + 3\text{H}_2(g) \rightleftharpoons 2\text{NH}_3(g) \]

\[ K_{eq} = \ \ \ \ \ \ \ \ \ \ ]

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.

\[ \text{I}_2(s) \rightleftharpoons \text{I}_2(g) \]

Real-World Connection

Discuss why sodium hydrogen carbonate is valuable in baking.
Section 18.1 Equilibrium: A State of Dynamic Balance (continued)

**Main Idea**

Calculating the Value of Equilibrium Constants

*Use with Example Problem 18-3, page 568.*

**Details**

**Summarize** Fill in the blanks to help you take notes while you read Example Problem 18-3.

**Problem** Calculate the value of $K_{eq}$ for the equilibrium constant expression.

$$K_{eq} = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

1. **Analyze the Problem**
   List the knowns and unknowns.
   - Known: the equilibrium constant expression:
   - Known: the concentration of each reactant and product:
     - $[NH_3] = \ldots$
     - $[N_2] = \ldots$
     - $[H_2] = \ldots$
   - Unknown: the value of the equilibrium constant

2. **Solve for the Unknown**
   Substitute the into the equilibrium and calculate its value.

$$K_{eq} = \frac{[0.533]}{[0.533]} = \ldots$$

3. **Evaluate the Answer**
   The given concentrations have _____ significant figures, therefore the answer must have _____ significant figures.
Chemical Equilibrium
Section 18.2 Factors Affecting Chemical Equilibrium

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 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 Chatelier’s principle

Use your text to define the following term.

__________________________________________
__________________________________________

Academic Vocabulary

stress

Define the following terms.

__________________________________________

volume

__________________________________________
Section 18.2 Factors Affecting Chemical Equilibrium (continued)

**Main Idea**

**Le Chatelier’s Principle**

*Use with pages 569–573.*

**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 18.3 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. 

Use your text to define each term.

solubility product constant

common ion

common ion effect

symbol

Define the following term.
Section 18.3 Using Equilibrium Constants (continued)

Main Idea

Calculating Equilibrium Concentrations

Use with Example Problem 18-4, page 576.

Details

Summarize Fill in the blanks to help you take notes while you read example Problem 18-4.

Problem

At 1405 K, hydrogen sulfide __________ to form ______ and a diatomic ___ molecule, S₂. The ______________ for the reaction is $2.27 \times 10^{-3}$.

What is the concentration of H₂(g) if $[S₂] = 0.0540 \text{ mol/L}$ and $[H₂S] = 0.184 \text{ mol/L}$?

1. Analyze the Problem

List the knowns and unknowns.

Known: $K_{eq}$, $[S₂]$, $[H₂S]$

Unknown: $[H₂]$

2. Solve for the Unknown

Write the equilibrium constant expression.

$K_{eq} =$

Substitute known quantities.

$K_{eq} =$

Solve for the unknown.

$[H₂] =$

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 18.3 Using Equilibrium Constants (continued)

Main Idea

Solubility Equilibria
Use with pages 577–583.

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.

is the 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 both doctors and chefs to understand solubility.

Calculating Molar Solubility from \( K_{sp} \)

Use with Example Problem 18-5, page 579.

Summarize Fill in the blanks to help you take notes while you read Example Problem 18-5.

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: \( K_{sp} (\text{CuCO}_3) = \) ________

Unknown: solubility (\( \text{CuCO}_3 \)) = ________
Section 18.3 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).

   \[ \text{s} = [\text{Cu}^{2+}] = \text{___________________________} \]
   Substitute \( \text{s} \) for \([\text{Cu}^{2+}]\) and \text{___________________________}.
   
3. Evaluate the Answer
   \( K_{\text{sp}} \) has ___ significant figures so the answer must be expressed with ___ significant figures.

Describe conditions in which precipitates are likely to form.

1. 
2. 
3. 

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 ____________.

Explain which reactants you would add to a solution to determine if it contained ions of mercury (\( \text{Hg}_2^{2+} \)). Use Figure 18-18 as a guide.
Now that you have read the chapter, review what you have learned.

**Describe** chemical equilibrium.

**Explain** Le Chatelier’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.
Acids and Bases

Before You Read

Review Vocabulary

Define the following term.

chemical equilibrium

Chapter 10

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.

Chapter 17

Identify five factors that influence reaction rate.

1. 
2. 
3. 
4. 
5. 
Acids and Bases
Section 19.1 Acids and Bases: An Introduction

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.

acidic solution

basic solution

Arrhenius model

Brønsted-Lowry model

conjugate acid

conjugate base

conjugate acid-base pair

amphoteric
Section 19.1 Acids and Bases: An Introduction (continued)

Properties of Acids and Bases
Use with pages 595–599.

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>
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<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.

H₂O(l) ⇌ H⁺(aq) + OH⁻(aq)

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.
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.

Monoprotic and Polyprotic Acids

Use with pages 600–601.

Explain what a polyprotic acid is.

Sequence the following equations in the steps of the ionization of phosphoric acid in the correct order.

1. $\text{HPO}_4^{2-}(aq) + \text{H}_2\text{O}(l) \rightleftharpoons \text{H}_2\text{O}^+(aq) + \text{PO}_4^{3-}(aq)$
2. $\text{H}_3\text{PO}_4(aq) + \text{H}_2\text{O}(l) \rightleftharpoons \text{H}_2\text{O}^+(aq) + \text{H}_2\text{PO}_4^{2-}(aq)$
3. $\text{H}_2\text{PO}_4^-(aq) + \text{H}_2\text{O}(l) \rightleftharpoons \text{H}_3\text{O}^+(aq) + \text{HPO}_4^-(aq)$

Define and give examples of an anhydride, distinguishing between those that produce an acid and those that produce a base.
Acids and Bases
Section 19.2 Strengths of Acids and Bases

Main Idea

Details

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. __________________________

New Vocabulary

Use your text to define each term.

strong acid

weak acid

acid ionization constant

strong base

weak base

base ionization constant

Academic Vocabulary

Define the following term.

significant
Section 19.2 Strengths of Acids and Bases (continued)

**Main Idea**

**Strengths of Acids**
*Use with pages 602–605.*

**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></td>
<td>hydroiodic</td>
<td></td>
</tr>
<tr>
<td>carbonic</td>
<td></td>
<td>hydrosulfuric</td>
<td></td>
</tr>
<tr>
<td>hydrobromic</td>
<td></td>
<td>hypochlorous</td>
<td></td>
</tr>
<tr>
<td>hydrochloric</td>
<td></td>
<td>nitric</td>
<td></td>
</tr>
<tr>
<td>hydrocyanic</td>
<td></td>
<td>perchloric</td>
<td></td>
</tr>
<tr>
<td>hydrofluoric</td>
<td></td>
<td>sulfuric</td>
<td></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.
Section 19.2 Strengths of Acids and Bases (continued)

**Main Idea**

**Strength of Bases**

*Use with pages 606 and 607.*

**Details**

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.

`ACIDS AND BASES`

- that are
- completely
- partially
- and have an whose value is
- larger when they are
- smaller when they are

**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 19.3 What is 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 19.3 What is pH? (continued)

Main Idea

Ion Product Constant for Water

Use with pages 608–609.

Using $K_w$ to Calculate $[H^+]$ and $[OH^-]$  

Use with Example Problem 19–1, page 609.

Details

Describe how the ion product constant for water is derived from the self-ionization equation.

\[
\begin{align*}
H_2O(\text{l}) & \leftrightarrow \quad \text{________________} \\
K_{eq} &= \text{________________} \\
K_{eq} [H_2O] &= \text{________________} \\
K_w &= [H^+] [OH^-] = \text{________________} \\
\end{align*}
\]

Summarize Fill in the blanks to help you take notes while you read Example Problem 19–1.

Problem

Calculate $[OH^-]$ using $K_w$ and the concentration of $\quad$, and determine if the solution is acidic, basic, or neutral.

Step 1: Analyze the Problem

Known: Unknown:

$[H^+] = \text{________________} \quad [OH^-] = \text{? mol/L}$

$K_w = \text{________________}$

Write what you can predict about $[OH^-]$:

Step 2: Solve for the Unknown

Write the ion product constant expression

$K_w = \text{________________}$

Solve for $[OH^-]$ by $\quad$.

$[OH^-] = \text{________________}$

$[OH^-] = \text{________________}$

Since $[H^+] > [OH^-]$, $\quad$. 
Section 19.3 What is pH? (continued)

**Main Idea**

**Details**

**pH and pOH**

*Use with pages 610–614.*

**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 19.4 Neutralization

Main Idea

**Details**

**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. 

**New Vocabulary**

**Define the following terms.**

neutralization reaction

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>salt</td>
<td></td>
</tr>
<tr>
<td>titration</td>
<td></td>
</tr>
<tr>
<td>equivalence point</td>
<td></td>
</tr>
<tr>
<td>acid-base indicator</td>
<td></td>
</tr>
<tr>
<td>end point</td>
<td></td>
</tr>
<tr>
<td>salt hydrolysis</td>
<td></td>
</tr>
<tr>
<td>buffer</td>
<td></td>
</tr>
<tr>
<td>buffer capacity</td>
<td></td>
</tr>
</tbody>
</table>
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 19–18 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:

\[
\text{HCOOH(aq)} + \text{NaOH(aq)} \rightarrow \text{HCOONa(aq)} + \text{H}_2\text{O(l)}
\]

\[
18.28 \text{ mL NaOH} \times \frac{\text{mol NaOH}}{0.01828 \text{ L NaOH}} = \text{_____ L NaOH}
\]

\[
0.01828 \text{ L NaOH} \times \frac{\text{mol HCOOH}}{1.828 \times 10^{-3} \text{ mol NaOH}} = \text{_____ mol HCOOH}
\]

\[
1.828 \times 10^{-3} \text{ mol HCOOH} / \text{_____ mol HCOOH} = \text{_____ } M \text{ HCOOH}
\]
Salt Hydrolysis

Use with pages 621–622.

Describe salt hydrolysis by completing the following statements.

Some aqueous salt solutions are neutral, some are basic, and some are _____. The reason for this is a process known as ____________.

In this process, the anions of the dissociated salt donate _______ to water. Salts that will hydrolyze have a weak acid and a _______ or a strong acid and a _______. A salt formed from a strong acid and a weak base will form an _________. A salt formed from a strong base and a weak acid will form a _________. Salts formed from weak acids and bases or from strong acids and bases will not hydrolyze and form _________.

Buffered Solutions

Use with pages 622–625.

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 left</td>
<td>The H⁺ ions react with F⁻ ions to form</td>
</tr>
<tr>
<td>add base right</td>
<td>The OH⁻ ions react with H⁺ ions to form water. This decreases the concentration of the H⁺ ions so that</td>
</tr>
<tr>
<td>A greater of the buffering molecules and ions in the solution leads to a of the solution.</td>
<td></td>
</tr>
<tr>
<td>A buffer has or a base with its of an acid and its</td>
<td></td>
</tr>
</tbody>
</table>
Acids and Bases  Chapter Wrap-Up

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 8

Compare and contrast monatomic ions and polyatomic ions.

Chapter 10

List five types of chemical reactions.

1. 

2. 

3. 

4. 

5. 
Redox Reactions
Section 20.1 Oxidation and Reduction

Main Idea

Use with pages 635–637.

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.

oxidation-reduction reaction
redox reaction
oxidation
reduction
oxidizing agent
reducing agent

Electron Transfer and Redox Reactions

Describe redox reactions by completing the statement below. Use Figure 20-1 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.

Main Idea

Detail
## Section 20.1 Oxidation and Reduction (continued)

### Main Idea

**Oxidizing and Reducing Agents**

*Use with page 638.*

### Details

**Compare and contrast an oxidizing agent and a reducing agent.**

- __________________________
- __________________________
- __________________________
- __________________________
- __________________________

### Summarize

*Fill in the blanks to help you take notes while you read Example Problem 20-1.*

**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.
**Main Idea**

**Determining Oxidation Numbers**
*Use with page 641.*

**Details**

**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 1A and 2A and aluminum in group 3A 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 643 of your text to complete the table, then label the oxidation numbers of the elements in the equation and indicate the change in each.

\[2\text{Al} + \text{Fe}_2\text{O}_3 \rightarrow 2\text{Fe} + \text{Al}_2\text{O}_3\]

<table>
<thead>
<tr>
<th>Element</th>
<th>Oxidation Number</th>
<th>Rule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fe in (\text{Fe}_2\text{O}_3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O in (\text{Fe}_2\text{O}_3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Al in (\text{Al}_2\text{O}_3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O in (\text{Al}_2\text{O}_3)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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

Use your text to define this term.

- oxidation-number method

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.
Main Idea

Balancing a Redox Reaction by the Oxidation-Number Method

Use with Example Problem 20-3, pages 645–646.

Details

Summarize Fill in the blanks to help you take notes while you read Example Problem 20-3.

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 _____.

276 Balancing Redox Equations
Section 20.2 Balancing Redox Equations (continued)

**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.

**Details**

- **3. Evaluate the Answer**
  - The number of atoms of each element is _____ on both sides of the equation. No subscripts have been ________.

**Balancing Net Ionic Redox Equations**

*Use with pages 646–647.*

**Describe** how the form of the balanced equation for the oxidation of copper by nitric acid, below:

\[ \text{Cu}(s) + 4\text{HNO}_3(aq) \rightarrow \text{Cu(NO}_3)_2(aq) + 2\text{NO}_2(g) + 2\text{H}_2\text{O}(l) \]

is changed when rewritten as:

\[ \text{Cu}(s) + 4\text{H}^+(aq) + 4\text{NO}_3^-(aq) \rightarrow \text{Cu}^{2+}(aq) + 2\text{NO}_3^-(aq) + 2\text{NO}_2(g) + 2\text{H}_2\text{O}(l) \]

**Balancing a Net Ionic Redox Equation**

*Use with Example Problem 20-4, pages 648–649.*

**Solve** Read Example Problem 20-4 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.

  \[ \text{ClO}_3^-(aq) + \text{I}^-(aq) \rightarrow \text{Cl}^-(aq) + \text{I}_2(s) \text{ (in acid solution)} \]

  **1. Analyze the Problem**

  - **Known:**
    - 
    - 
    - 
  
  - **Unknown:**
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.

\[ \text{ClO}_3^- (aq) + 6I^- (aq) \rightarrow \text{Cl}^- (aq) + 3I_2(s) \text{ (in acid solution)} \]

**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 _____.
Redox Reactions
Section 20.3 Half-Reactions

Main Idea

Skim Section 3 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.

species

half-reaction

New Vocabulary

Identifying Half-Reactions
Use with pages 650–651.

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>$4Fe + 3O_2 \rightarrow 2Fe_2O_3$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$4Fe + 3Cl_2 \rightarrow 2Fe_2Cl_3$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Section 20.3 Half-Reactions (continued)

**Main Idea**

Balancing Redox Equations by Half-Reactions

*Use with page 651.*

**Details**

Sequence the steps for balancing by half-reactions.

___ Adjust the coefficients so that the number of electrons lost in oxidation equals the number of electrons gained in reduction.

___ Write the net ionic equation for the reaction, omitting spectator ions.

___ Add the balanced half-reactions and return spectator ions.

___ Write the oxidation and reduction half-reactions for the net ionic equation.

___ Balance the atoms and charges in each half-reaction.

**Summarize** Fill in the blanks to help you take notes while you read Example Problem 20-5.

- **Problem**
  Balance the redox equation for the ______ of permanganate and sulfur dioxide when sulfur dioxide is bubbled into an _____ solution of _________________.
  \[ \text{KMnO}_4(aq) + \text{SO}_2(g) \rightarrow \text{MnSO}_4(aq) + \text{K}_2\text{SO}_4(aq) \]

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 Mn \( ^{2+} \) is ____. The reduction half-reaction is _________________.

   **Step 3(a):** Balance the atoms and charges in the half-reaction.
   
   _______________________________________________________________________

280 Half-Reactions
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.


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

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.
Define the following terms.

- energy
- chemical potential
- spontaneous process
- oxidation
- reduction
- half-reaction

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 10-10.

aluminum, copper, calcium, gold, rubidium, iron, lead, potassium
## Electrochemistry

### Section 21.1 Voltaic Cells

**Main Idea**

<table>
<thead>
<tr>
<th>Details</th>
</tr>
</thead>
</table>

**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**: 
  - **battery**: 

**Academic Vocabulary**

- **Define the following term.**

  - **involve**: 

---

284 Voltaic Cells
Section 21.1 Voltaic Cells (continued)

**Main Idea**

Use with page 663.

**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.

- 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.
- The electrons flow from the zinc strip and pass through the external circuit to the copper strip.
- Electrons are produced in the oxidation half-cell according to this half-reaction: \( \text{Zn(s)} \rightarrow \text{Zn}^{2+}(aq) + 2e^- \).
- Electrons enter the reduction half-cell where the following half-reaction occurs: \( \text{Cu}^{2+}(aq) + 2e^- \rightarrow \text{Cu(s)} \).
Section 21.1 Voltaic Cells (continued)

Main Idea

Calculating Electrochemical Cell Potential
Use with page 666.

Details

Describe reduction potential in relation to an electrode.

Analyze Table 21-1. 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 21-1.

Problem

Calculate the overall cell reaction and the standard potential for the half-cells of a voltaic cell.

$I_2(s) + 2e^- \rightarrow 2I^-(aq)$

$Fe^{2+}(aq) + 2e^- \rightarrow Fe(s)$

1. Analyze the Problem.

List the known and the unknown.

Known: Standard reduction potentials for the half-cells

Unknown: 
Using Standard Reduction Potentials

Use with page 671.

2. Solve for the unknown.

Find the standard reduction potentials for half-reactions.

\[ E^{0}_{I_2|I^-} = \] ________________

\[ E^{0}_{Fe^{2+}|Fe} = \] ________________

Rewrite the half reactions in the correct direction.

reduction half-cell reaction: ________________

oxidation half-cell reaction: ________________

overall cell reaction: \[ I_2(s) + Fe(s) \rightarrow Fe^{2+}(aq) + 2I^-(aq) \]

Balance the reaction if necessary:

Calculate cell standard potential:

\[ E^{0}_{cell} = E^{0}_{reduction} - E^{0}_{oxidation} \]

\[ E^{0}_{cell} = +0.536 \text{ V} - \] ________________

\[ E^{0}_{cell} = + \] ________________

Write the reaction using cell notation:

3. Evaluate the answer.

The answer seems reasonable given the ________________

of the ________________ that comprise it.

Write the steps for the process of predicting whether any proposed redox reaction will occur spontaneously.

1. ________________

2. ________________

3. ________________

4. ________________

5. ________________
Electrochemistry
Section 21.2 Types of 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. ______________________________________

**New Vocabulary**

Use your text to define each term.

- **dry cell**
- **primary battery**
- **secondary battery**
- **fuel cell**
- **corrosion**
- **galvanizing**

**Academic Vocabulary**

Define the following term.

- **trend**
Section 21.2 Types of Batteries (continued)

Main Idea

**Dry Cells**  
*Use with pages 673–675.*

Details

**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.

---

*Electrochemistry* 289
Main Idea

**Lead-Acid Storage Battery**
*Use with pages 675–676.*

Explain how the following overall reaction of lead-acid batteries is different from traditional redox reactions.

\[ \text{Pb(s)} + \text{PbO}_2(\text{s}) + 4\text{H}^+ (\text{aq}) + 2\text{SO}_4^{2-} (\text{aq}) \rightarrow 2\text{PbSO}_4(\text{s}) + 2\text{H}_2\text{O(l)} \]

Details

**Lithium Batteries**
*Use with pages 676–677.*

List two reasons that scientists and engineers have focused a lot of attention on the element lithium to make batteries.

1. 
2. 

Describe two applications of lightweight lithium batteries.

**Fuel Cells**
*Use with pages 678–679.*

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. 

Types of Batteries
Section 21.2 Types of Batteries (continued)

**Main Idea**

**Corrosion**

*Use with pages 679–682.*

**Details**

**Compare** rusting of metal to redox reactions in voltaic cells.

**Draw** and label the parts of the corrosion reaction in Figure 21-14. 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. 
Electrochemistry
Section 21.3 Electrolysis

**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. __________________________________________

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

- electrolysis
  __________________________________________
- electrolytic cell
  __________________________________________

**Academic Vocabulary** Define the following term.

- conduct
  __________________________________________
Section 21.3 Electrolysis (continued)

Main Idea

Reversing Redox Reactions

Use with page 683.

Applications of Electrolysis

Use with pages 684–687.

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. 

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

Describe how electrochemistry is involved in producing energy in batteries.
Hydrocarbons

Before You Read

**Review Vocabulary**

**Define each term.**

- **covalent bond**

- **Lewis structure**

**Chapter 7**

**Write** the electron configuration of a carbon atom.

**Chapter 9**

**Draw** the Lewis structure for NH₃.

**Chapter 13**

**Compare and contrast** melting and boiling.
Hydrocarbons
Section 22.1 Alkanes

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 alkanes.

1. ______________________________________________________
   ______________________________________________________

2. ______________________________________________________
   ______________________________________________________

3. ______________________________________________________
   ______________________________________________________

New Vocabulary
Use your text to define each term.

organic compound
   ______________________________________________________
   ______________________________________________________

h.ydrocarbon
   ______________________________________________________
   ______________________________________________________

alkane
   ______________________________________________________
   ______________________________________________________

homologous series
   ______________________________________________________
   ______________________________________________________

parent chain
   ______________________________________________________
   ______________________________________________________

substituent group
   ______________________________________________________
   ______________________________________________________
Organic Chemistry

Use with page 697.

**Main Idea**

**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 _____.

Hydrocarbons

Use with pages 698–699.

Label the web below with the correct name for each model of methane.

1. CH₄

2.

3.

4.
Section 22.1 Alkanes (continued)

**Main Idea**

**Straight-Chain Alkanes**

*Use with pages 699–700.*

- 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>

**Details**

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.

________________________________________________________________________
________________________________________________________________________

1 line long, and # before has been removed t/o already
Section 22.1 Alkanes (continued)

**Main Idea**

**Branched-Chain Alkanes**

*Use with page 701.*

**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

**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
Hydrocarbons
Section 22.2 Cyclic Alkanes and Alkane Properties

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.

cyclic hydrocarbon

cycloalkane

saturated hydrocarbon

unsaturated hydrocarbon

Academic Vocabulary

Define the following terms.

infer
Section 22.2 Cyclic Alkanes and Alkane Properties (continued)

**Main Idea**

**Cycloalkanes**

*Use with page 706.*

**Details**

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 708–709.*

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>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Main Idea

Multiple Carbon-Carbon Bonds
Use with page 710.

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>

Real-World Connection

Explain the process of cleaning an oil spill in the ocean using what you have learned about the immiscibility of alkanes. Why are oil spills dangerous for birds like ducks?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
Hydrocarbons
Section 22.3 Alkenes and Alkynes

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.

New Vocabulary

Use your text to define each term.

alkene

alkyne

Academic Vocabulary

Define the following term.

formula
Section 22.3 Alkenes and Alkynes (continued)

Main Idea

**Alkenes**

*Use with page 711.*

**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 22–3 in your text.

- **Problem**
  
  Name the following alkene.
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 page 714.

Compare and contrast alkenes and alkynes.
Hydrocarbons
Section 22.4 Isomers

Main Idea

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

1. 
2. 

Details

Use your text to define each term.

**isomer**

**structural isomer**

**stereoisomer**

**geometric isomer**

**chirality**

**asymmetric carbon**

**optical isomer**

**polarized light**

**optical rotation**
Organize the outline below.

I. Structural 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. ____________________________
            ii. ____________________________
            ____________________________
         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 22.4 Isomers (continued)

**Main Idea**

**Optical Isomers**

*Use with page 719.*

**Details**

**Identify** the types of isomers shown below. Which pair are optical isomers?

- **D-glyceraldehyde**
  - CHO
  - HO 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 C Cl
  - Cl C H

- **cis-1,2-dichloroethene**
  - H C H
  - Cl C Cl

**COMPARE**

Explain what a pair of shoes and crystals of the organic compound tartaric acid have in common.
Hydrocarbons
Section 22.5 Aromatic Hydrocarbons and Petroleum

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

Main Idea

Match the names of these two processes with their definitions.

1. fractional distillation
2. cracking

fractional distillation is done to break the larger molecules of petroleum components into smaller molecules.

cracking separates petroleum into simpler components.

Academic Vocabulary

Define the following term.

isolate
Aromatic Compounds

Use with pages 723–724.

**Main Idea**

**Classify** the properties of aromatic and aliphatic compounds.

<table>
<thead>
<tr>
<th>Structural Characteristics</th>
<th>Reactivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aromatic Compounds</td>
<td></td>
</tr>
<tr>
<td>Aliphatic Compounds</td>
<td></td>
</tr>
</tbody>
</table>

**Model** Draw a model of a fused ring system.

**Details**

**Explain** how substituted benzene rings are numbered.

**Number** the substituted benzene ring in the structure below, then name the structure.

![Molecular structure](image)
Section 22.5 Aromatic Hydrocarbons and Petroleum (continued)

### Main Idea

**Natural Sources of Hydrocarbons**
*Use with pages 725–726.*

**Details**

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.*

1. Vapors travel up through the column.
2. Temperature is controlled to remain near 400° at the bottom of the fractionating tower.
3. Hydrocarbons with fewer carbon atoms remain in the vapor phase until they reach regions of cooler temperatures farther up the column.
4. Hydrocarbons with more carbon atoms condense closer to the bottom or the tower and are drawn off.
5. Petroleum boils and gradually moves toward the top.

### Rating Gasolines
*Use with pages 726–727.*

**Details**

**Explain** *why branched-chain alkanes make better gasolines than straight-chain hydrocarbons.*

---

**Real-World Connection**

Describe how changing the grade of gasoline you use could help engine knocking.

---

*Hydrocarbons* 311
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

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.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>periodic table</td>
<td></td>
</tr>
<tr>
<td>compound</td>
<td></td>
</tr>
<tr>
<td>halogens</td>
<td></td>
</tr>
<tr>
<td>chemical bond</td>
<td></td>
</tr>
<tr>
<td>catalyst</td>
<td></td>
</tr>
</tbody>
</table>

**Chapter 7**

Explain organic chemistry.

**Chapter 22**

Compare and contrast stereoisomers with structural isomers.

---

*Substituted Hydrocarbons and Their Reactions* 313
Substituted Hydrocarbons and Their Reactions

Section 23.1 Functional Groups

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.

New Vocabulary

functional group

halocarbon

alkyl halide

aryl halide

substitution reaction

halogenation

Academic Vocabulary

Define the following term.

structure
Section 23.1 Functional Groups (continued)

**Main Idea**

Functional Groups

*Use with pages 737–738.*

**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>
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 23-2 on page 740. 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 23.2 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.*

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>hydroxyl group</td>
<td></td>
</tr>
<tr>
<td>alcohol</td>
<td></td>
</tr>
<tr>
<td>denatured alcohol</td>
<td></td>
</tr>
</tbody>
</table>

Define the following terms and write the general formula for each term.

<table>
<thead>
<tr>
<th>Term</th>
<th>General Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>ether</td>
<td></td>
</tr>
<tr>
<td>amine</td>
<td></td>
</tr>
</tbody>
</table>

Define the following term.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>compound</td>
<td></td>
</tr>
</tbody>
</table>
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

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.
Write the general formula for ethers:

\[ \text{General formula for ethers} \]

Draw a structure for the following molecule.

ethyl ether

Amines

Use with pages 745–746.

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:

\[ \text{General formula for amines} \]

Draw a structure for the following molecule.

ethylamine
Substituted Hydrocarbons and Their Reactions

Section 23.3 Carbonyl Compounds

Main Idea

Organic Compounds Containing the Carbonyl Group

New Vocabulary

ketone

carboxylic acid

carboxyl group

ester

amide

Define the following term:

Use your text to define each term.

Skim Section 3 of your text. Write two questions that come to mind from reading the headings and the illustration captions.

1. 

2. 

Define the following terms and write the general formula of each.

carbonyl group

aldehyde

condensation reaction

Define the following term.

Academic Vocabulary

process
Section 23.3 Carbonyl Compounds (continued)

Main Idea

Organic Compounds Containing the Carbonyl Group

Use with pages 747–752.

Details

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.

____________________

____________________

____________________

Carboxylic Acids

Use with page 749.

Draw a molecule of a carboxylic acid.

[Diagram of ethanoic acid (acetic acid)]

Ethanoic acid (acetic 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 23.3 Carbonyl Compounds (continued)

**Main Idea**

**Condensation Reactions**

Use with pages 752–753.

- **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.

**Details**

- **Complete** the following condensation reaction.
  
  \[ \text{RCOOH} + \text{R'OHH} \rightarrow \text{______________} \]

**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 23.4 Other Reactions of Organic Compounds

### Main Idea

**Reactions of Organic Substances**

### 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

### Academic Vocabulary

Define the following term.

- convert
Section 23.4 Other Reactions of Organic Compounds (continued)

**Main Idea**

Reactions of Organic Substances

*Use with page 754.*

**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

______________________________________________
Predicting Products of Organic Reactions

Use with Pages 759–760.

Describe oxidation-reduction reactions by completing the following statements.

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 _______.

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 23.5 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.

polymers
monomer
polymerization reaction
addition polymerization
condensation polymerization
plastic
thermoplastic
thermosetting

Define the following term.

bond
Section 23.5 Polymers (continued)

The Age of Polymers

Use with page 761.

Reactions Used to Make Polymers

Use with page 762–764.

Main Idea

The Age of Polymers

Use with page 761.

Reactions Used to Make Polymers

Use with page 762–764.

Details

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>Polyethylene terephthalate</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
Section 23.5 Polymers (continued)

**Main Idea**

Materials Made from Polymers: Uses and Recycling

*Use with page 764.*

**Details**

*Identify the common polymer. Use Table 23-4 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>

*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 contrasts with the _____ of paper waste and _____ of aluminum waste that are 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

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

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.
Define the following terms.

- **hydrogen bond**
- **isomers**
- **functional group**
- **polymers**

**Chapter 13** Illustrate the hydrogen bonding between water molecules.

**Chapter 23** Illustrate the molecules for flouroethane and 1,2 difluoropronane.
The Chemistry of Life
Section 24.1 Proteins

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.

<table>
<thead>
<tr>
<th>Main Idea</th>
</tr>
</thead>
<tbody>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>-----------</td>
</tr>
</tbody>
</table>

New Vocabulary

Use your text to define each term.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>protein</td>
<td></td>
</tr>
<tr>
<td>amino acid</td>
<td></td>
</tr>
<tr>
<td>peptide bond</td>
<td></td>
</tr>
<tr>
<td>peptide</td>
<td></td>
</tr>
<tr>
<td>denaturation</td>
<td></td>
</tr>
<tr>
<td>enzyme</td>
<td></td>
</tr>
<tr>
<td>substrate</td>
<td></td>
</tr>
<tr>
<td>active site</td>
<td></td>
</tr>
</tbody>
</table>
Section 24.1 Proteins (continued)

**Main Idea**

**Protein Structure**
*Use with pages 775–777.*

**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.
Main Idea

Identify the peptide bond between the following amino acids.

\[ \text{H} \quad R_1 \quad \text{H} \quad R_2 \]
\[ \quad \text{N} - \text{C} - \text{C} - \text{N} - \text{C} - \text{C} - \text{OH} \]
\[ \quad \text{H} \quad \text{H} \quad \text{O} \quad \text{H} \quad \text{O} \]

Details

Explain why Gly-Phe is a different molecule than the Phe-Gly.

Describe three changes in environment that will uncoil or otherwise denature a protein.

1. 

2. 

3. 

Draw an enzyme/substrate complex with the enzyme and substrates labeled.
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.
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

Academic Vocabulary

Define the following term.

- complex
Section 24.2 Carbohydrates (continued)

Kinds of Carbohydrates
Use with page 781.

Main Idea

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>

Use with pages 782–783.
Section 24.3 Lipids

Main Idea

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. 

New Vocabulary

Use your text to define each term.

lipid

fatty acid

triglyceride

saponification

phospholipid

wax

steroid
Section 24.3 Lipids (continued)

**Main Idea**

**What is a lipid?**

*Use with pages 784–787.*

**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 24.3 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

Define the following term.

sequence
Section 24.4 Nucleic Acids (continued)

**Main Idea**

**Structure of Nucleic Acids**  
*Use with page 788.*

**Details**

Draw a diagram of a nucleotide. Label all of the parts: sugar, phosphate group, and nitrogen-containing base.

![Diagram of a nucleotide](attachment:image.png)

**DNA: The Double Helix**  
*Use with pages 789–790.*

**Write** a statement that differentiates between nucleotides and nucleic acids.

**Sequence** the events of DNA replication. The first one has been done for you.

___ Hydrogen bonds form between new nitrogen bases and the existing strand.

___ Two nucleotide strands unzip.

___ Nitrogen bases pair adenine with thymine, cytosine with guanine.

1 An enzyme breaks the hydrogen bonds between the nitrogen bases.

___ The nucleotide strands separate to expose the nitrogen bases.

___ Free nucleotides are delivered by enzymes from the surrounding environment.

**Predict** the complimentary base pairing given the following strand of nucleotides.

ATCTATCGGATATCTG
### Main Idea

**RNA**

*Use with page 791.*

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>

### Details

**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 24.5 Metabolism

Main Idea | Details
--- | ---

**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**
  __________________________________________
Section 24.5 Metabolism (continued)

**Main Idea**

**Anabolism and Catabolism**

*Use with pages 792–793.*

**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 793.*

**Write** the reaction of photosynthesis. Label the individual molecules.

**Identify** the redox process that occurs during photosynthesis.
Section 24.5 Metabolism (continued)

**Main Idea**

**Cellular Respiration**

*Use with page 794.*

**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 24.5 Metabolism (continued)

**Main Idea**

**Fermentation**

*Use with pages 794–795.*

**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.
The Chemistry of Life  Chapter Wrap-Up

Now that you have read the chapter, review what you have learned. Write out the major concepts from the chapter.

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

Explain why someone with a liver disorder might be advised to avoid overexertion.
# Nuclear Chemistry

## Before You Read

### Review Vocabulary

**Isotopes**

Define the following terms.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>isotopes</td>
<td></td>
</tr>
<tr>
<td>nuclear reaction</td>
<td></td>
</tr>
<tr>
<td>electron</td>
<td></td>
</tr>
</tbody>
</table>

### 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 4-13 as a reference.

**Identify** the primary factor in determining an atom’s stability.
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.

radioisotope

X ray

Define the following terms.

attain

extract

process
Section 25.1 Nuclear Radiation (continued)

The Discovery of Radioactivity

Use with page 806.

Contrast chemical and nuclear reactions.

<table>
<thead>
<tr>
<th>Chemical Reactions</th>
<th>Nuclear Reactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>bonds are and formed</td>
<td>nuclei emit</td>
</tr>
<tr>
<td>atoms are, though they may be rearranged</td>
<td>are converted into atoms of another element</td>
</tr>
<tr>
<td>reaction rate by pressure, temperature, concentration, and catalyst</td>
<td>reaction rate by pressure, temperature, concentration, 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>

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 25.1 Nuclear Radiation (continued)

Main Idea

Types of Radiation

Use with pages 806–809.

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.
Nuclear Chemistry
Section 25.2 Radioactive Decay

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 radioactive decay.

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

Use your text to define each term.

nucleon

strong nuclear force

band of stability

positron emission

positron

electron capture

radioactive decay series
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.

Nuclear Stability

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.
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 12-5 in your text.

You Try It

• Problem

Write a balanced nuclear equation for the alpha decay of uranium-238 \( ^{238}_{92} \text{U} \).

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.

Mass number: 238 = X + ___  \( X = 238 - 4 \)

Mass number of \( X \) = ___

Using each particle’s atomic number, make sure the atomic number is conserved on each side of the reaction arrow.

Atomic number: 92 = ___  \( X = 92 - ___ \)

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.

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.
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 transmutation of one element into another.

Write three facts you discovered about transmutation.

1. 
2. 
3. 

Use your text to define each term.

<table>
<thead>
<tr>
<th>New Vocabulary</th>
</tr>
</thead>
<tbody>
<tr>
<td>transmutation</td>
</tr>
<tr>
<td>induced transmutation</td>
</tr>
<tr>
<td>transuranium elements</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Academic Vocabulary</th>
</tr>
</thead>
<tbody>
<tr>
<td>half-life</td>
</tr>
<tr>
<td>radiochemical dating</td>
</tr>
</tbody>
</table>

Define the following term.

<table>
<thead>
<tr>
<th>Academic Vocabulary</th>
</tr>
</thead>
<tbody>
<tr>
<td>react</td>
</tr>
</tbody>
</table>
Section 25.3 Transmutation (continued)

**Main Idea**

**Induced Transmutation**

*Use with pages 815–816.*

**Details**

Sequence the steps in Rutherford’s induced transformation of nitrogen-14 into oxygen.

\[
\begin{align*}
\text{\textsuperscript{4}} _2 \text{He} \text{ bombarding alpha particle} + \\
\rightarrow \text{p}^+ \text{ proton}
\end{align*}
\]

**Radioactive Decay Rates**

*Use with page 817.*

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.
Section 25.3 Transmutation (continued)

Main Idea

Calculating Amount of Remaining Isotope

Use with Example Problem 25-3, page 818.

Details

Solve Read Example Problem 25–3 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
   
   \[ n = \frac{49}{24.5} \]
   
   Amount remaining =
   
   Amount remaining =
   
   Amount remaining =
   
   Amount remaining =

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 ____. The answer, ____ is equal to ____ the original quantity.

Radiochemical Dating

Use with page 820.

Write the balanced nuclear equation for carbon dating.
Nuclear Chemistry
Section 25.4 Fission and Fusion of Atomic Nuclei

Main Idea

Skim Section 4 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.

mass defect

nuclear fission

critical mass

breeder reactor

nuclear fusion

thermonuclear reaction
Section 25.4 Fission and Fusion of Atomic Nuclei (continued)

Main Idea

Nuclear Reactions and Energy

Use with pages 821–822.

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.

Name ____________________________ Date ____________________________
Section 25.4 Fission and Fusion of Atomic Nuclei (continued)

**Main Idea**

**Nuclear Reactors**
*Use with pages 824–825.*

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.

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: ______________________________________
Nuclear Chemistry
Section 25.5 Applications and Effects of Nuclear Reactions

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 radioactive decay.

Write three questions you have about nuclear radiation.

1. 
2. 
3. 

Use your text to define each term.

ionizing radiation

radiotrace

Define the following term.
detect
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 subst-
ance. 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.
Section 25.5 Applications and Effects of Nuclear Reactions (continued)

Main Idea

Biological Effects of Radiation

Use with pages 829–831.

Details

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 

Real-World Connection

Create a warning label that will identify the dangers of a radioactive material to users.

Nuclear Chemistry  Chapter Wrap-Up

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.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

366  Chapter Wrap-Up
Chemistry in the Environment

Before You Read

Review the following concepts.

Explain the difference between a mixture and a solution.

Explain the difference between solutes and a solvent.

Explain the difference between solutions and aqueous solutions.

Explain the difference between an acidic solution and a basic solution.

Review Vocabulary

Define the following terms.

combined gas law

chemical equilibrium

acid-base indicator

pH
Chemistry in the Environment
Section 26.1 Earth’s Atmosphere

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 Earth’s atmosphere.

Write three facts you discovered about environmental chemistry.

1. ________________________________
2. ________________________________
3. ________________________________

New Vocabulary

atmosphere
Use your text to define each term.

______________________________

______________________________

______________________________

troposphere

______________________________

______________________________

______________________________

stratosphere

______________________________

______________________________

______________________________

A Balanced Atmosphere

Observe the picture on page 840 of your text. Describe one example of a chemical process shown in the photo.

__________________________________________

__________________________________________

__________________________________________
Section 26.1 Earth’s Atmosphere (continued)

**Main Idea**

Structure of Earth’s Atmosphere

*Use with page 842.*

**Details**

Label each atmospheric layer in the diagram below, and indicate whether temperatures increase or decrease at each of the bottom four layers.

---

**Compositions of Earth’s Atmosphere**

*Use with pages 842–843.*

**Organize** the table below to include three solids, the three most common gases other than nitrogen or oxygen, and a liquid found in the atmosphere.

<table>
<thead>
<tr>
<th>Solids</th>
<th>Gases</th>
<th>Liquid</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Describe** the troposphere by completing the following paragraph.

Roughly ____ of the mass of all atmospheric gases is found in the _________. The main two gases are _________________. They make up a total of ____ of the molecules in this layer.
Section 26.1 Earth’s Atmosphere (continued)

### Chemistry in the Outer Atmosphere
*Use with pages 843–844.*

Describe the processes of photodissociation and photoionization.

- [ ]

Describe how ozone is produced.

- [ ]

Sequence the steps in the thinning of the ozone layer.

1. CFCs become unstable due to high-energy radiation and break down, forming ClO and O₂.
2. Cl atoms speed up the depletion of ozone.
3. Chlorine monoxide combines with free oxygen atoms to regenerate free chlorine atoms and oxygen molecules.
4. CFCs diffuse into the stratosphere.

### Chemistry in the Stratosphere
*Use with pages 844–846.*
Explain how CFCs can cause damage to the atmosphere. Include the precautions to help slow the damage.

Explain how acid rain is formed.

1. Power plants release ____________________________
   __________________

2. Sulfur dioxide combines with _______ to form ______________,
   then ___________ forms when ______________ reacts with moisture in the air.

3. Acid rain can also form when car exhaust combines with
   ______________ to form ______________.

4. Acidic moisture ______________________________.

Describe the problems caused by acid in the atmosphere.
Chemistry in the Environment
Section 26.2 Earth’s Water

Main Idea

**Skim** Section 2 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.

**hydrosphere**

__________________________________________________________________________

**salinity**

__________________________________________________________________________

**desalination**

__________________________________________________________________________

Academic Vocabulary

Define the following terms.

**specific**

__________________________________________________________________________

**specify**

__________________________________________________________________________

The Hydrosphere

*Use with page 850.*

Create a circle graph that identifies each of the areas of water on the planet.

The Water Cycle

*Use with page 850.*

Identify the three main activities of the water cycle.
Section 26.2 Earth’s Water (continued)

Earth’s Oceans
Use with pages 851–852.

Trace a drop of rain through the water cycle. Use Figure 26-2 in your text as a guide.

Explain how the salinity of ocean water remains fairly constant over millions of years.

Ocean water contains dissolved ____ , which give the water a salty taste. The salts come from calcium, magnesium and sodium that are dissolved from _________________. Rivers transport the dissolved elements to the oceans. Sulfur and chlorine may be added from erupting ________. As rivers, volcanoes, and atmospheric processes add new substances to ________, elements are removed from oceans by biological processes and _____________.

Sequence the process within a desalination tube.

____ A desalination cylinder holds more than three million fibers.
____ Desalinated water flows through the inside of the fibers and is collected.
____ The water molecules pass inward through the walls of the fibers, and the salts are held back.
____ Seawater is forced under pressure into cylinders containing hollow, semi-permeable fibers.

Earth’s Freshwater
Use with page 852.

Identify how much water is used by an average person in the United States for each of the following.

cooking and drinking ______
bathing, laundering, and housecleaning ______
flushing toilets ______
watering lawns ______

Main Idea

Details
Section 26.2 Earth’s Water (continued)

**Main Idea**

**Human Impact on the Hydrosphere**

*Use with page 853.*

Explain why everyday use of cleaners and detergents leads to water pollution and the death of aquatic life.

**Details**

**Municipal Water and Sewage Treatment**

*Use with pages 853–854.*

Describe the steps in water treatment by completing the table below.

<table>
<thead>
<tr>
<th>Step in Water Treatment</th>
<th>Result of Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>coarse filtration</td>
<td></td>
</tr>
<tr>
<td>sedimentation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>water is passed through a bed of sand</td>
</tr>
<tr>
<td>aeration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>water is treated with substances that kill bacteria</td>
</tr>
</tbody>
</table>

Analyze the differences between the treatment of bacteria in freshwater treatment and sewage treatment.

In freshwater treatment, ______ are ______ from the water to purify the water. In sewage treatment, __________ are increased to promote the growth of ________ to biodegrade ________.
Chemistry in the Environment

Section 26.3 Earth’s Crust

Main Idea

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.

Write three facts you discovered about the crust of Earth.

1.  
2.  
3.  

New Vocabulary

lithosphere

The Lithosphere

Use with pages 855–857.

Use your text to define the following term.

Classify the eight most abundant components of the lithosphere found in Table 26-3 as metals, metalloids, or nonmetals. Use the periodic table for help.

Metals:  

Metalloids:  

Nonmetals:  

List Earth’s major regions from the surface to the center of the planet.

1.  
2.  
3.  
4.  

Details
Classify each of the mineral compounds below as oxide, sulfide, or carbonate.

<table>
<thead>
<tr>
<th>Mineral Compound</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>SrCO₃</td>
<td></td>
</tr>
<tr>
<td>MnO₂</td>
<td></td>
</tr>
<tr>
<td>MgCO₃</td>
<td></td>
</tr>
<tr>
<td>FeS₂</td>
<td></td>
</tr>
<tr>
<td>SnO₂</td>
<td></td>
</tr>
<tr>
<td>Al₂O₃</td>
<td></td>
</tr>
<tr>
<td>BaCO₃</td>
<td></td>
</tr>
<tr>
<td>PbS</td>
<td></td>
</tr>
</tbody>
</table>

SYNTHESIZE

Explain why periodic properties govern the state of combination in which elements are found in nature.
Chemistry in the Environment

Section 26.4 Cycles in the Environment

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

1. 
2. 
3. 

New Vocabulary

Use your text to define each term.

greenhouse effect

global warming

nitrogen fixation

Academic Vocabulary

Define these terms.

cOMPONENT

Maintain
Trace the pathway of carbon through the environment. Use Figure 26-18 as a guide.

Compare and contrast the greenhouse effect and global warming.

[Additional lines for writing answers]
Section 26.4 Cycles in the Environment (continued)

Main Idea

The Nitrogen Cycle
Use with pages 860–861.

Details

Describe how lightning forms a route for nitrogen fixation.

1. 

2. 

3. 

Write the chemical equations for nitrogen fixation caused by lightning.

1. 

2. 

3. 

Describe how bacteria form a route for nitrogen fixation.

1. 

2. 

3. 

Real-World Connection

Explain the relationship between cutting down rain forests and the greenhouse effect.
Chemistry in the Environment  Chapter Wrap-Up

After reading this chapter, list the main concepts below.

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

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

Some people might argue that problems identified by scientists are just cycles of chemicals in nature and are not caused by humans. Explain whether you agree or disagree, based on what you have learned in the chapter.

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________