化学 Chemistry

An Introduction to General, Organic, and Biological Chemistry

(Eleventh Edition)

普通化学、有机化学和生物化学导论（第11版）

本书适合与健康相关的不同专业的学生学习化学知识，如营养及护理、环境科学、农业科学等专业。本书旨在帮助学生了解物质的结构及性质与其在健康及环境中的作用之间的联系。书中设有“Chemistry Link to Health”、“Chemistry Link to Environment”等兴趣阅读框，帮助学生了解化学原理的应用。并通过概念讨论、解题指引、综合性习题等，介绍解决问题的策略。全书内容丰富生动，语言清晰易懂。

本书主要内容包括：化学与测量，物质与能量，原子与元素，化合物与化学键，化学计算与化学反应，气体，溶液，酸和碱，核反应，有机化学简介——烷烃，不饱和烃，含氧和硫的有机化合物，碳水化合物，羧酸、酯、胺和酰胺，脂类，氨基酸、蛋白质和酶，核酸及蛋白质合成，代谢途径及能量产生。

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Chemistry

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化学

普通化学、有机化学和生物化学导论

（第11版）

[美] Karen C. Timberlake

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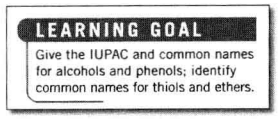
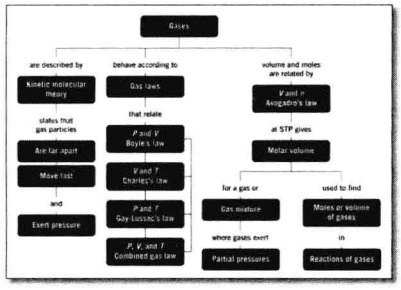
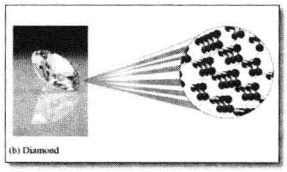
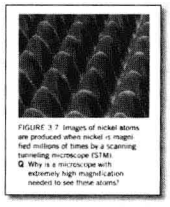
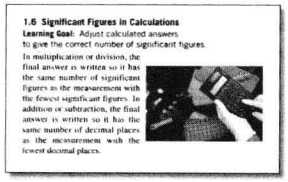
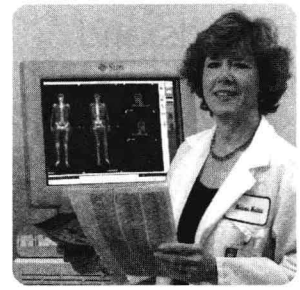
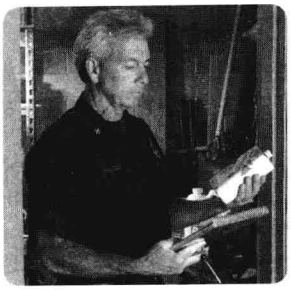
Engage students in the world of chemistry

"I never teach my pupils; I only attempt to provide the conditions in which they can learn."
—Albert Einstein

Feature	Description	Benefit	Page
Learning Goals 	**Learning Goals** at the beginning of each section identify the key concepts for that section and provide a roadmap for your study.	Help you focus your studying by emphasizing what is most important in each section	411
Writing Style The periodic table is an arrangement of the elements by increasing atomic number. A vertical column or group on the periodic table contains elements with similar properties. A horizontal row is called a period.	Timberlake's accessible **writing style** is based on careful development of chemical concepts suited to the skills and backgrounds of allied health students.	Helps you understand new terms and chemical concepts	119
UPDATED! Concept Maps 	**Concept Maps** at the end of each chapter show how all the key concepts fit together.	Encourage learning by providing a **visual** guide to the interrelationship among all the concepts in each chapter	240
UPDATED! Macro-to-Micro Art 	**Macro-to-Micro Art** utilizes photographs and drawings to illustrate recognizable objects and their atomic structure.	Helps you connect the world of atoms and molecules to the macroscopic world	89
UPDATED! Art Program 	The **art program** is beautifully rendered, pedagogically effective, and includes questions with all the figures.	Helps you think critically using photos and illustrations	96
NEW! Chapter Review 	The **Chapter Review** at the end of each chapter includes Learning Goals and new visual thumbnails to summarize the key points in each section.	Helps you determine your mastery of the chapter concepts and study for your tests	39





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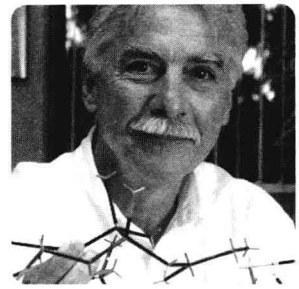

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APPLICATIONS AND ACTIVITIES

Explore Your World

Chemistry Link to Health

Career Focus

Chemistry Link to the Environment

Chemistry Link to Industry

Chemistry Link to History

Guide to Problem Solving

QUESTIONS AND PROBLEMS

Units of Measurement

1.9 Compare the units you would use and the units that a student in Mexico would use to measure each of the following:
a. your body mass
b. your height
c. amount of gasoline to fill a gas tank
d. temperature at noon

1.10 Why are each of the following statements confusing, and how would you make them clear using metric (SI) units?
a. I rode my bicycle for a distance of 15 today.
b. My dog weighs 15.
c. It is hot today. It is 30.
d. I lost 1.5 last week.

1.11 State the name of the unit and the type of measurement indicated for each of the following quantities:
a. 4.8 m **b.** 325 g **c.** 1.5 mL
d. 480 s **e.** 28 °C

1.12 State the name of the unit and the type of measurement indicated for each of the following quantities:
a. 0.8 L **b.** 3.6 cm **c.** 4 kg
d. 35 lb **e.** 373 K

1.4 Scientific Notation

LEARNING GOAL
Write a number in scientific notation.

TUTORIAL
Scientific Notation

Scientific Notation

In chemistry, we use numbers that are very large or very small. We might measure something as tiny as the width of a human hair, which is about 0.000 008 m. Or perhaps we want to count the number of hairs in the average human scalp, which is about 100 000 hairs (see Figure 1.6). In this text, we add spaces between sets of three digits when it helps make the places easier to count. However, it is more convenient to write large and small numbers in *scientific notation.*

Item	Standard Number	Scientific Notation
Width of a human hair	0.000 008 m	8×10^{-6} m
Hairs on a human scalp	100 000 hairs	1×10^{5} hairs

FIGURE 1.6 Humans have an average of 1×10^5 hairs on their scalps. Each hair is about 8×10^{-6} m wide.
Q Why are large and small numbers written in scientific notation?

Writing a Number in Scientific Notation

A number written in **scientific notation** has three parts: a coefficient, a power of 10, and a measurement unit. For example, the number 2400 m is written in scientific notation as 2.4×10^3 m. The coefficient is 2.4, the 3 is the power of 10, and m is the measurement unit of meters. The coefficient is determined by moving the decimal point to the left to give a coefficient that is at least 1 but less than 10. Because we moved the decimal point

Example 4

Subtract:

14.5 g	One decimal place
− 2.5 g	One decimal place
12.	Calculator display
12.0 g	Answer, zero written after the decimal point

SAMPLE PROBLEM 1.5

Decimal Places in Addition and Subtraction

Perform the following calculations and give the answers with the correct number of decimal places:

a. 27.8 cm + 0.235 cm **b.** 153.247 g − 14.82 g

SOLUTION

a. 28.0 cm (rounded off to one decimal place)
b. 138.43 g (rounded off to two decimal places)

STUDY CHECK 1.5

Perform the following calculations and give the answers with the correct number of decimal places:

a. 82.45 mg + 1.245 mg + 0.000 56 mg **b.** 4.259 L − 3.8 L

QUESTIONS AND PROBLEMS

Significant Figures in Calculations

1.27 Why do we usually need to round off calculations that use measured numbers?

1.28 Why do we sometimes add a zero to a number in a calculator display?

1.29 Round off each of the following measurements to three significant figures:
a. 1.854 kg
b. 88.2038 L
c. 0.004 738 265 cm
d. 8807 m
e. 1.832×10^5 s

1.30 Round off each of the measurements in Problem 1.29 to two significant figures.

1.31 Round off or add zeros to each of the following to give an answer with three significant figures:
a. 5080 L **b.** 37 400 g
c. 104 720 m **d.** 0.000 250 82 s

1.32 Round off or add zeros to each of the following to give an answer with two significant figures:
a. 5 100 000 L **b.** 26 711 s
c. 0.003 378 m **d.** 56.982 g

1.33 For each of the following problems, give an answer with the correct number of significant figures:
a. 45.7×0.034 **b.** $0.002\,78 \times 5$
c. $\dfrac{34.56}{1.25}$ **d.** $\dfrac{(0.2465)(25)}{1.78}$

1.34 For each of the following problems, give an answer with the correct number of significant figures:
a. 400×185 **b.** $\dfrac{2.40}{(4)(125)}$
c. $0.825 \times 3.6 \times 5.1$ **d.** $\dfrac{3.5 \times 0.261}{8.24 \times 20.0}$

1.35 For each of the following, give an answer with the correct number of decimal places:
a. 45.48 cm + 8.057 cm
b. 23.45 g + 104.1 g + 0.025 g
c. 145.675 mL − 24.2 mL
d. 1.08 L − 0.585 L

1.36 For each of the following, give an answer with the correct number of decimal places:
a. 5.08 g + 25.1 g
b. 85.66 cm + 104.10 cm + 0.025 cm
c. 24.568 mL − 14.25 mL
d. 0.2654 L − 0.2585 L

CONCEPT CHECK 1.7

Prefixes

Fill in the blanks with the correct symbol.

a. 1000 g = 1 ___ g **b.** 0.01 m = 1 ___ m

c. 1×10^6 L = 1 ___ L

ANSWER

a. The prefix for 1000 is *kilo*; 1000 g = 1 kg

b. The prefix for 0.01 is *centi*; 0.01 m = 1 cm

c. The prefix for 1×10^6 is *mega*; 1×10^6 L = 1 ML

SAMPLE PROBLEM 1.6

Prefixes

The storage capacity for a hard disk drive (HDD) is specified using prefixes: megabyte (MB), gigabyte (GB), or terabyte (TB). Indicate the storage capacity in bytes for each of the following hard disk drives. Suggest a reason for describing a HDD storage capacity in gigabytes or terabytes.

a. 5 MB **b.** 2 GB

SOLUTION

a. The prefix *mega* (M) in MB is equal to 1 000 000 or 1×10^6. Thus, 5 MB is equal to 5 000 000 (5×10^6) bytes.

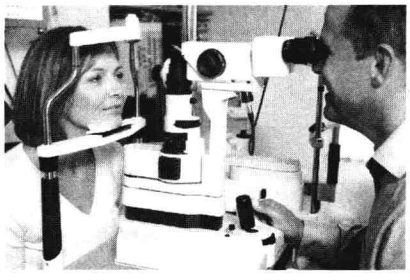
b. The prefix *giga* (G) in GB is equal to 1 000 000 000 or 1×10^9. Thus, 2 GB is equal to 2 000 000 000 (2×10^9) bytes.

Expressing HDD capacity in gigabytes or terabytes gives a more reasonable number to work with than a number with many zeros or a large power of 10.

STUDY CHECK 1.6

Hard drives now have a storage capacity of 1.5 TB. How many bytes are stored?

A terabyte hard disk drive stores 10^{12} bytes of information.



Using a retinal camera, an ophthalmologist photographs the retina of an eye.

Measuring Length

An ophthalmologist may measure the diameter of the retina of an eye in centimeters (cm), whereas a surgeon may need to know the length of a nerve in millimeters (mm). When the prefix *centi* is used with the unit meter, it becomes *centimeter*, a length that is one-hundredth of a meter (0.01 m). When the prefix *milli* is used with the unit meter, it becomes *millimeter*, and a length that is one-thousandth of a meter (0.001 m). There are 100 cm and 1000 mm in a meter.

If we compare the lengths of a millimeter and a centimeter, we find that 1 mm is 0.1 cm; there are 10 mm in 1 cm. These comparisons are examples of **equalities**, which show the relationship between two units that measure the same quantity. For example, in the equality 1 m = 100 cm, each quantity describes the same length but in a different unit. In every equality, each quantity has both a number and a unit.

First quantity			Second quantity	
1	m	=	100	cm
↑	↑		↑	↑
Number	+ unit		Number	+ unit

This example of an equality shows the relationship between meters and centimeters.

Examples of Some Length Equalities

1 m = 100 cm = 1×10^2 cm

1 m = 1000 mm = 1×10^3 mm

1 cm = 10 mm = 1×10^1 mm

Some metric units for length are compared in Figure 1.8.

b. In liposuction, a doctor removes fat deposits from a person's body. If body fat has a density of 0.94 g/mL and 3.0 L of fat is removed, how many pounds of fat were removed from the patient?

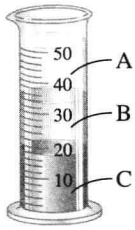
1.106 An 18-karat gold necklace is 75% gold by mass, 16% silver, and 9.0% copper.

a. What is the mass, in grams, of the necklace if it contains 0.24 oz of silver?

b. How many grams of copper are in the necklace?

c. If 18-karat gold has a density of 15.5 g/cm^3, what is the volume in cubic centimeters?

1.107 A graduated cylinder contains three liquids A, B, and C, which have different densities and do not mix: mercury (D = 13.6 g/mL), vegetable oil (D = 0.92 g/mL), and water (D = 1.00 g/mL). Identify the liquids A, B, and C in the cylinder.



1.108 A mouthwash is 21.6% ethyl alcohol by mass. If each bottle contains 0.358 pt of mouthwash with a density of 0.876 g/mL, how many kilograms of ethyl alcohol are in 180 bottles of the mouthwash?

A mouthwash may contain ethyl alcohol.

Answers

Answers to Study Checks

1.1 **a.** iron, **b.** tin, and **d.** water are chemicals.

1.2 **a.** 4.25×10^5 m **b.** 8.6×10^{-7} g

1.3 **a.** 36 m **b.** 0.0026 L
c. 3.8×10^3 g **d.** 1.3 kg

1.4 **a.** 0.4924 **b.** 0.0080 or 8.0×10^{-3}
c. 2.0

1.5 **a.** 83.70 mg **b.** 0.5 L

1.6 1 500 000 000 000 (1.5×10^{12}) bytes

1.7 **a.** 1000 **b.** 0.001

1.8 **a.** $\frac{62.2\text{ km}}{1\text{ h}}$ and $\frac{1\text{ h}}{62.2\text{ km}}$ **b.** $\frac{10\,\mu g}{1\text{ kg}}$ and $\frac{1\text{ kg}}{10\,\mu g}$

1.9 1.89 L

1.10 0.44 oz

1.11 25 g of fat

1.12 1.05 g/cm^3

1.13 2.2 g/mL

1.14 1.50 mL

Answers to Selected Questions and Problems

1.1 Many chemicals are listed on a vitamin bottle such as vitamin A, vitamin B_3, vitamin B_{12}, folic acid, and so on.

1.3 No. All of the ingredients listed are chemicals.

1.5 Among the things you might do to help yourself succeed in chemistry: attend lecture regularly, review the *Learning Goals*, keep a problem notebook, read the text actively, read the chapter before lecture, join a study group, use your instructor's office hours, and others.

1.7 **a**, **c**, **e**, and **f**

1.9 In the United States, **a.** body mass is measured in pounds, **b.** height in feet and inches, **c.** amount of gasoline in gallons, and **d.** temperature in degrees Fahrenheit (°F). In Mexico, **a.** body mass is measured in kilograms, **b.** height in meters, **c.** amount of gasoline in liters, and **d.** temperature in degrees Celsius (°C).

1.11 **a.** meter, length **b.** gram, mass
c. milliliter, volume **d.** second, time
e. degree Celsius, temperature

1.13 **a.** 5.5×10^4 m **b.** 4.8×10^2 g
c. 5×10^{-6} cm **d.** 1.4×10^{-4} s
e. 7.2×10^{-3} L **f.** 6.7×10^5 kg

1.15 **a.** 7.2×10^3 cm **b.** 3.2×10^{-2} kg
c. 1×10^4 L **d.** 6.8×10^{-2} m

1.17 **a.** measured **b.** exact
c. exact **d.** measured

1.19 **a.** 6 oz of hamburger **b.** none
c. 0.75 lb, 350 g **d.** none (definitions are exact)

1.21 **a.** not significant **b.** significant
c. significant **d.** significant
e. not significant

QUESTIONS AND PROBLEMS

Classification of Matter

2.1 Classify each of the following as a pure substance or a mixture:

a. baking soda ($NaHCO_3$) **b.** a blueberry muffin
c. ice (H_2O) **d.** zinc (Zn)
e. Trimix (oxygen, nitrogen, and helium) in a scuba tank

2.2 Classify each of the following as a pure substance or a mixture:

a. a soft drink **b.** propane (C_3H_8)
c. a cheese sandwich **d.** an iron (Fe) nail
e. salt substitute (KCl)

2.3 Classify each of the following pure substances as an element or a compound:

a. a silicon (Si) chip **b.** hydrogen peroxide (H_2O_2)
c. oxygen (O_2) **d.** rust (Fe_2O_3)
e. methane (CH_4) in natural gas

2.4 Classify each of the following pure substances as an element or a compound:

a. helium gas (He) **b.** mercury (Hg) in a thermometer
c. sugar ($C_{12}H_{22}O_{11}$) **d.** sulfur (S)
e. lye (NaOH)

2.5 Classify each of the following mixtures as homogeneous or heterogeneous:

a. vegetable soup **b.** sea water
c. tea **d.** tea with ice and lemon slices
e. fruit salad

2.6 Classify each of the following mixtures as homogeneous or heterogeneous:

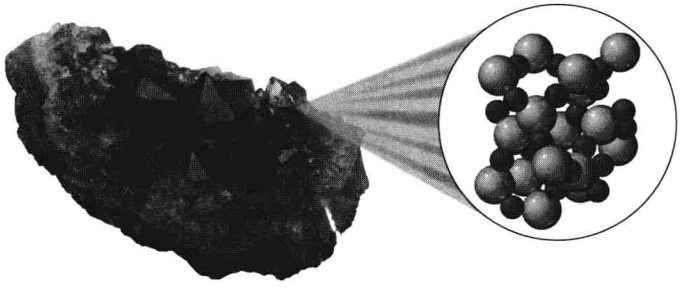
a. nonfat milk **b.** chocolate-chip ice cream
c. gasoline **d.** peanut-butter-and-jelly sandwich
e. cranberry juice

LEARNING GOAL

Identify the states and physical and chemical properties of matter.

2.2 States and Properties of Matter

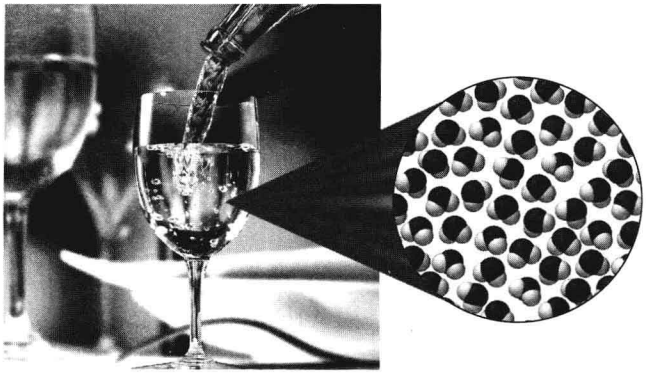
On Earth, matter exists in one of three *physical forms* called the **states of matter**: *solids*, *liquids*, and *gases*. A **solid**, such as a pebble or a baseball, has a definite shape and volume. You can probably recognize several solids within your reach right now such as books, pencils, or a computer mouse. In a *solid*, strong attractive forces hold the particles such as atoms or molecules close together. The particles are arranged in such a rigid pattern they can only vibrate slowly in fixed positions. For many solids, this rigid structure produces a crystal such as that seen in amethyst.



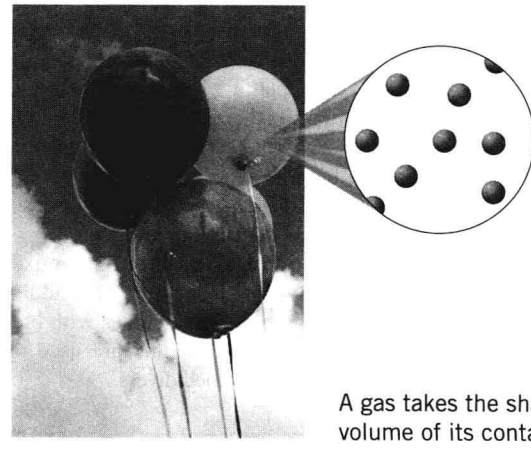
Amethyst, a solid, is a purple form of quartz (SiO_2).

A **liquid** has a definite volume, but not a definite shape. In a *liquid*, the particles move in random directions but are sufficiently attracted to each other to maintain a definite volume, although not a rigid structure. Thus, when water, oil, or vinegar is poured from one container to another, the liquid maintains its own volume but takes the shape of the new container.

A **gas** does not have a definite shape or volume. In a *gas*, the particles are far apart, have little attraction to each other, and move at high speeds, taking the shape and volume of their container. When you inflate a bicycle tire, the air, which is a gas, fills the entire volume of the tire. The propane gas in a tank fills the entire volume of the tank. Table 2.1 compares the three states of matter.



Water as a liquid takes the shape of its container.



A gas takes the shape and volume of its container.

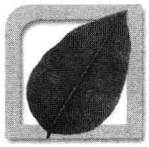
Step 4 Set Up Problem

$$48\,000\,\text{J} \times \frac{1\ \text{cal}}{4.184\,\text{J}} = 11\,000\ \text{cal}\ (1.1 \times 10^4\ \text{cal})$$

Two SFs | Exact | Two SFs

STUDY CHECK 2.3

The burning of 1.0 g of coal produces 8.4 kcal. How many joules are produced?

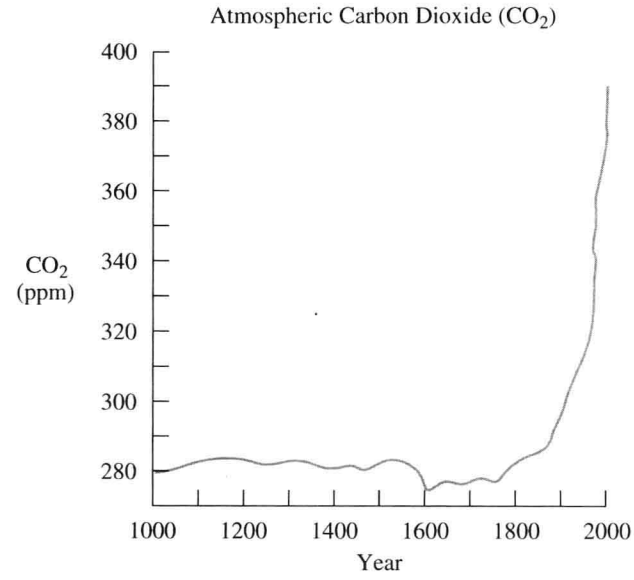


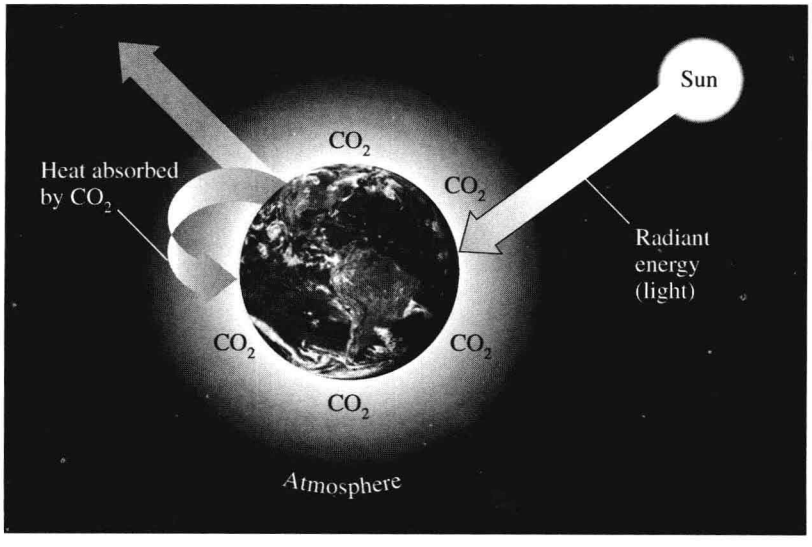
Chemistry Link to the Environment

CARBON DIOXIDE AND GLOBAL WARMING

Earth's climate is a product of interactions between sunlight, the atmosphere, and the oceans. The Sun provides us with energy in the form of solar radiation. Some of this radiation is reflected back into space. The rest is absorbed by the clouds, atmospheric gases including carbon dioxide, and Earth's surface. For millions of years, concentrations of carbon dioxide (CO_2) have fluctuated. However in the last 100 years, the amount of carbon dioxide (CO_2) gas in our atmosphere has increased significantly. From the years 1000 to 1800, the atmospheric carbon dioxide averaged 280 ppm. But since the beginning of the Industrial Revolution in 1800 up until 2005, the level of atmospheric carbon dioxide has risen from about 280 ppm to about 390 ppm, a 40% increase.

As the atmospheric CO_2 level increases, more solar radiation is trapped by the atmospheric gases, which raises the temperature at the surface of Earth. Some scientists have estimated that if the carbon dioxide level doubles from its level before the Industrial Revolution, the average global temperature could increase by 2 to 4.4 °C. Although this seems to be a small temperature change, it could have dramatic impact worldwide. Even now, glaciers and snow cover in much of the world have diminished. Ice sheets in Antarctica and Greenland are melting faster and breaking apart. Although no one knows for sure how rapidly the ice in the polar regions is melting, this accelerating change will contribute to a rise in sea level. In the twentieth century, the sea level increased by about 20 cm. Some scientists predict the sea level will rise 1 m in this century. Such an increase will have a major impact on coastal areas.





Heat from the Sun is trapped by the CO_2 layer in the atmosphere.

Until recently, the carbon dioxide level was maintained as algae in the oceans and the trees in the forests utilized the carbon dioxide. However, the ability of these and other forms of plant life to absorb carbon dioxide is not keeping up with the increase in carbon dioxide. Most scientists agree that the primary source of the increase of carbon dioxide is the burning of fossil fuels such as gasoline, coal, and natural gas. The cutting and burning of trees in the rain forests (deforestation) also reduces the amount of carbon dioxide removed from the atmosphere.

Worldwide efforts are being made to reduce the carbon dioxide produced by burning fossil fuels that heat our homes, run our cars, and provide energy for industries. Scientists are exploring ways to provide alternative energy sources and to reduce the effects of deforestation. Meanwhile, we can reduce energy use in our homes by using appliances that are more energy efficient such as replacing incandescent light bulbs with fluorescent lights. Such an effort worldwide will reduce the possible impact of global warming and at the same time save our fuel resources.

SAMPLE PROBLEM 2.4

Converting Celsius to Fahrenheit

A room is heated to 22 °C. If that temperature is lowered by 1 °C, it can save as much as 5% in energy costs. What temperature, in Fahrenheit degrees, should be set to lower the temperature by 1 °C?

SOLUTION

Step 1 **Given** 22 °C − 1 °C = 21 °C **Need** T_F

Step 2 **Plan**

$$T_C \xrightarrow{\text{Temperature equation}} T_F$$

Step 3 **Equality/Conversion Factor**

$$T_F = 1.8(T_C) + 32$$

Step 4 **Set Up Problem** Substitute the Celsius temperature into the equation and solve.

$$T_F = 1.8(21) + 32$$

Two SFs Exact

$$T_F = 38 + 32 \qquad \text{1.8 is exact; 32 is exact}$$

$$= 70.\ °F \qquad \text{Answer to the ones place}$$

In the equation, *the values of 1.8 and 32 are exact numbers*, which do not affect the number of SFs.

STUDY CHECK 2.4

In the process of making ice cream, rock salt is added to crushed ice to chill the ice cream mixture. If the temperature drops to −11 °C, what is it in Fahrenheit degrees?

SAMPLE PROBLEM 2.5

Converting Fahrenheit to Celsius

In a type of cancer treatment called *thermotherapy*, temperatures as high as 113 °F are used to destroy cancer cells. What is that temperature in degrees Celsius?

SOLUTION

Step 1 **Given** 113 °F **Need** T_C

Step 2 **Plan**

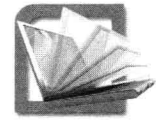
$$T_F \xrightarrow{\text{Temperature equation}} T_C$$

Step 3 **Equality/Conversion Factor**

$$T_C = \frac{T_F - 32}{1.8}$$

Step 4 **Set Up Problem** Substitute the Fahrenheit temperature into the equation and solve.

$$T_C = \frac{T_F - 32}{1.8}$$



Career Focus

SURGICAL TECHNOLOGIST

"As a surgical technologist, I assist the doctors during surgeries," says Christopher Ayars, surgical technologist, Kaiser Hospital. "I am there to help during general or orthopedic surgery by passing instruments, holding retractors, and maintaining the sterile field. Our equipment for surgery is sterilized by steam that is heated to 270 °F, which is the same as 130 °C."

Surgical technologists assist with surgical procedures by preparing and maintaining surgical equipment, instruments, and supplies; providing patient care in an operating room setting; preparing and maintaining a sterile field; and ensuring that there are no breaks in aseptic technique. Instruments, which have been sterilized, are wrapped and sent to surgery where they are checked again before they are opened.

$$T_C = \frac{(113 - 32)}{1.8} \qquad \text{32 is exact; 1.8 is exact}$$

$$= \frac{81}{1.8} = 45\ ^\circ\text{C} \qquad \text{Answer to the ones place}$$

STUDY CHECK 2.5

A child has a temperature of 103.6 °F. What is this temperature on a Celsius thermometer?

SAMPLE PROBLEM 2.6

Converting from Celsius to Kelvin Temperature

A dermatologist may use liquid cryogenic nitrogen at −196 °C to remove skin lesions and some skin cancers. What is the temperature of the liquid nitrogen in kelvins?

SOLUTION

Step 1 **Given** −196 °C **Need** T_K

Step 2 **Plan**

$$T_C \xrightarrow[\text{equation}]{\text{Temperature}} T_K$$

Step 3 **Equality/Conversion Factor**

$$T_K = T_C + 273$$

Step 4 **Set Up Problem** Substitute the Celsius temperature into the equation and solve.

$$T_K = T_C + 273$$

$$T_K = -196 + 273$$

$$= 77\ \text{K} \qquad \text{Answer to the ones place}$$

STUDY CHECK 2.6

On the planet Mercury, the average night temperature is 13 K, and the average day temperature is 683 K. What are these temperatures in degrees Celsius?

QUESTIONS AND PROBLEMS

Temperature

2.21 Your friend who is visiting from Canada just took her temperature. When she reads 99.8 °F, she becomes concerned that she is quite ill. How would you explain this temperature to your friend?

2.22 You have a friend who is using a recipe for flan from a Mexican cookbook. You notice that he set your oven temperature at 175 °F. What would you advise him to do?

2.23 Solve the following temperature conversions:

a. 37.0 °C = _____ °F **b.** 65.3 °F = _____ °C
c. −27 °C = _____ K **d.** 62 °C = _____ K
e. 114 °F = _____ °C

2.24 Solve the following temperature conversions:

a. 25 °C = _____ °F **b.** 155 °C = _____ °F
c. −25 °F = _____ °C **d.** 224 K = _____ °C
e. 145 °C = _____ K

2.25 **a.** A patient with hyperthermia has a temperature of 106 °F. What does this read on a Celsius thermometer?
b. Because high fevers can cause convulsions in children, the doctor wants to be called if the child's temperature goes over 40.0 °C. Should the doctor be called if a child has a temperature of 103 °F?

2.26 **a.** Hot compresses for a patient are prepared with water heated to 145 °F. What is the temperature of the hot water in degrees Celsius?
b. During extreme hypothermia, a boy's temperature dropped to 20.6 °C. What was his temperature on the Fahrenheit scale?

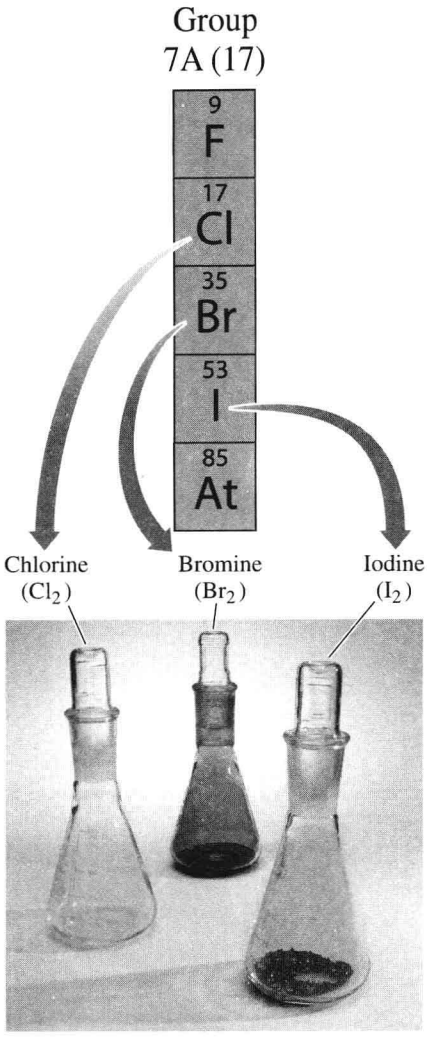


FIGURE 3.5 Chlorine (Cl_2), bromine (Br_2), and iodine (I_2) are examples of halogens from Group 7A (17).
Q What elements are in the halogen group?

Group 2A (2) elements—beryllium (Be), magnesium (Mg), calcium (Ca), strontium (Sr), barium (Ba), and radium (Ra)—are called the **alkaline earth metals**. They are shiny metals like those in Group 1A (1), but they are not as reactive.

The **halogens** are found on the right side of the periodic table in Group 7A (17). They include the elements fluorine (F), chlorine (Cl), bromine (Br), iodine (I), and astatine (At) (see Figure 3.5). The halogens, especially fluorine and chlorine, are highly reactive and form compounds with most of the elements.

Group 8A (18) contains the **noble gases**—helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe), and radon (Rn). They are quite unreactive and are seldom found in combination with other elements.

SAMPLE PROBLEM 3.3

Group and Period Numbers of Some Elements

Give the period and group for each of the following elements and identify as a representative or transition element:

a. iodine **b.** manganese **c.** barium **d.** gold

SOLUTION

a. Iodine (I), Period 5, Group 7A (17), is a representative element.
b. Manganese (Mn), Period 4, Group 7B (7), is a transition element.
c. Barium (Ba), Period 6, Group 2A (2), is a representative element.
d. Gold (Au), Period 6, Group 1B (11), is a transition element.

STUDY CHECK 3.3

Strontium is an element that gives a brilliant red color to fireworks.

a. In what group is strontium found?
b. In what chemical family is strontium found?
c. In what period is strontium found?
d. What are the name and symbol of the element in Period 3 that is in the same group as strontium?
e. What alkali metal, halogen, and noble gas are in the same period as strontium?

Strontium provides the red color in fireworks.

Chemistry Link to Health

ELEMENTS ESSENTIAL TO HEALTH

Of all the elements, only about 20 are essential for the well-being and survival of the human body. Of those, four elements—oxygen, carbon, hydrogen, and nitrogen—which are representative elements in Period 1 and Period 2 on the periodic table, make up 96% of our body mass. Most of the food in our daily diet provides these elements to maintain a healthy body. These elements are found in carbohydrates, fats, and proteins. Most of the hydrogen and oxygen is found in water, which makes up 55–60% of our body mass.

The macrominerals—Ca, P, K, Cl, S, Na, and Mg—are located in Period 3 and Period 4 of the periodic table. They are involved in the formation of bones and teeth, maintenance of heart and blood vessels, muscle contraction, nerve impulses, acid–base balance of body fluids, and regulation of cellular metabolism. The macrominerals are present in lower amounts than the major elements, so that smaller amounts are required in our daily diets.

The other essential elements, called microminerals or trace elements, are mostly transition elements in Period 4 along with Mo and I in Period 5. They are present in the human body in small amounts, some less than 100 mg. In recent years, the detection of such small amounts has improved so that researchers can more easily identify the roles of trace elements. Some trace elements such as arsenic, chromium and selenium are toxic at higher levels in the body but are still required by the body. Other elements such as tin and nickel are thought to be essential, but their metabolic role has not yet been determined. Some examples and the amounts present in a 60-kg person are listed in Table 3.3.