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Chemistry in Our Lives

Learning Goals

- Define the term chemistry and identify substances as chemicals.
- Describe the activities that are part of the scientific method.
- Identify strategies that are effective for learning. Develop a study plan for learning chemistry.
- Review math concepts used in chemistry: place values, positive and negative numbers, percentages, solving equations, and interpreting graphs.
- Write a number in scientific notation.

Chapter Outline

Chapter Opener: Forensic Scientist

1.1 Chemistry and Chemicals

1.2 Scientific Method: Thinking Like a Scientist

Chemistry Link to Health: Early Chemist: Paracelsus

1.3 Studying and Learning Chemistry

1.4 Key Math Skills for Chemistry

1.5 Writing Numbers in Scientific Notation

Clinical Update: Forensic Evidence Helps Solve the Crime

Key Math Skills

- Identifying Place Values (1.4)
- Using Positive and Negative Numbers in Calculations (1.4)
- Calculating Percentages (1.4)
- Solving Equations (1.4)
- Interpreting Graphs (1.4)
- Writing Numbers in Scientific Notation (1.5)

Answers and Solutions to Text Problems

1.1 **a.** Chemistry is the study of the composition, structure, properties, and reactions of matter.
b. A chemical is a substance that has the same composition and properties wherever it is found.

1.2 Your friends may give a variety of definitions, most of which will probably not agree with the dictionary definitions.

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

1.4 Many chemicals are listed on a cereal box such as vitamin A, vitamin B_6, vitamin B_{12}, vitamin C, folic acid, sugar, salt, and iron.

1.5 Typical items found in a medicine cabinet and some of the chemicals they contain are as follows:

Antacid tablets: calcium carbonate, cellulose, starch, stearic acid, silicon dioxide
Mouthwash: water, alcohol, thymol, glycerol, sodium benzoate, benzoic acid
Cough suppressant: menthol, beta-carotene, sucrose, glucose

1.6 Typical chemicals found in dishwashing products are: water, sodium lauryl sulfate, sodium laureth sulfate, dimethyl amine oxide, sodium chloride, phenoxyethanol.

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b. A hypothesis proposes a possible explanation for a natural phenomenon.
c. An experiment is a procedure that tests the validity of a hypothesis.
d. An observation is a description or measurement of a natural phenomenon.
e. An observation is a description or measurement of a natural phenomenon.
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1.11 There are several things you can do that will help you successfully learn chemistry, including forming a study group, going to class, asking yourself questions as you read new material in the textbook, working *Sample Problems* and *Study Checks*, working *Practice Problems* and checking *Answers*, reading the assignment ahead of class, self-testing during and after reading each Section, retesting on new information a few days later, going to the instructor's office hours, and keeping a problem notebook.

1.12 Many things make it difficult to learn chemistry, including not going to class regularly, not working *Sample Problems* and *Study Checks*, not reading the assignment ahead of class, not going to the instructor's office hours, and waiting until the night before an exam to study.

1.13 Ways you can enhance your learning of chemistry include:
a. forming a study group.
c. asking yourself questions while reading the text.
e. answering the Engage questions.

1.14 Ways you can enhance your learning of chemistry include:
a. studying different topics at the same time.
c. attending review sessions.
d. working the problems again after a few days.
e. keeping a problem notebook.

1.15 **a.** The bolded 8 is in the thousandths place.
b. The bolded 6 is in the ones place.
c. The bolded 6 is in the hundreds place.

1.16 **a.** The bolded 5 is in the tenths place.
b. The bolded 7 is in the tens place.
c. The bolded 0 is in the hundredths place.

1.17 **a.** $15 - (-8) = 15 + 8 = 23$
b. $-8 + (-22) = -30$
c. $4 \times (-2) + 6 = -8 + 6 = -2$

1.18 **a.** $-11 - (-9) = -11 + 9 = -2$
b. $34 + (-55) = -21$
c. $\dfrac{-56}{8} = -7$

1.19 **a.** $\dfrac{21 \text{ flu shots}}{25 \text{ patients}} \times 100\% = 84\%$ received flu shots
b. total grams of alloy = 56 g silver + 22 g copper = 78 g of alloy
$\dfrac{56 \text{ g silver}}{78 \text{ g alloy}} \times 100\% = 72\%$ silver
c. total number of coins = 11 nickels + 5 quarters + 7 dimes = 23 coins
$\dfrac{7 \text{ dimes}}{23 \text{ coins}} \times 100\% = 30\%$ dimes

1.20 **a.** $\dfrac{22 \text{ boys}}{35 \text{ babies}} \times 100\% = 63\%$ boys
b. total grams of alloy = 67 g gold + 35 g zinc = 102 g of alloy
$\dfrac{35 \text{ g zinc}}{102 \text{ g alloy}} \times 100\% = 34\%$ zinc
c. total number of coins = 15 pennies + 14 dimes + 6 quarters = 35 coins
$\dfrac{15 \text{ pennies}}{35 \text{ coins}} \times 100\% = 43\%$ pennies

1.21 **a.**
$$\begin{aligned} 4a + 4 &= 40 \\ 4a + \cancel{4} - \cancel{4} &= 40 - 4 \\ 4a &= 36 \\ \frac{\cancel{4}a}{\cancel{4}} &= \frac{36}{4} \\ a &= 9 \end{aligned}$$

b.
$$\begin{aligned} \frac{a}{6} &= 7 \\ \cancel{6}\left(\frac{a}{\cancel{6}}\right) &= 6(7) \\ a &= 42 \end{aligned}$$

1.22 **a.**
$$\begin{aligned} 2b + 7 &= b + 10 \\ 2b + \cancel{7} - \cancel{7} &= b + 10 - 7 \\ 2b &= b + 3 \\ 2b - b &= \cancel{b} - \cancel{b} + 3 \\ b &= 3 \end{aligned}$$

b.
$$\begin{aligned} 3b - 4 &= 24 - b \\ 3b - \cancel{4} + \cancel{4} &= 24 - b + 4 \\ 3b &= 28 - b \\ 3b + b &= 28 - \cancel{b} + \cancel{b} \\ 4b &= 28 \\ \frac{\cancel{4}b}{\cancel{4}} &= \frac{28}{4} \\ b &= 7 \end{aligned}$$

1.23 **a.** The graph shows the relationship between the temperature of a cup of tea and time.
b. The vertical axis measures temperature, in °C.
c. The values on the vertical axis range from 20 °C to 80 °C.
d. As time increases, the temperature decreases.

1.24 **a.** The horizontal axis measures time, in minutes.
b. The values on the horizontal axis range from 0 min to 100 min.
c. After 20 min, the temperature of the tea is about 56 °C.
d. About 38 min were required for the tea to reach a temperature of 45 °C.

1.25 **a.** Move the decimal point four places to the left to give 5.5×10^4.
b. Move the decimal point two places to the left to give 4.8×10^2.
c. Move the decimal point six places to the right to give 5×10^{-6}.
d. Move the decimal point four places to the right to give 1.4×10^{-4}.
e. Move the decimal point three places to the right to give 7.2×10^{-3}.
f. Move the decimal point five places to the left to give 6.7×10^5.

1.26 **a.** Move the decimal point eight places to the left to give 1.8×10^8.
b. Move the decimal point five places to the right to give 6×10^{-5}.
c. Move the decimal point two places to the left to give 7.5×10^2.
d. Move the decimal point one place to the right to give 1.5×10^{-1}.
e. Move the decimal point two places to the right to give 2.4×10^{-2}.
f. Move the decimal point three places to the left to give 1.5×10^3.

1.27 **a.** 7.2×10^3, which is also 72×10^2, is larger than 8.2×10^2.
b. 3.2×10^{-2}, which is also 320×10^{-4}, is larger than 4.5×10^{-4}.
c. 1×10^4 or 10 000 is larger than 1×10^{-4} or 0.0001.
d. 6.8×10^{-2} or 0.068 is larger than 0.000 52.

1.28 **a.** 5.5×10^{-9}, which is also $0.000\,005\,5 \times 10^{-3}$, is smaller than 4.9×10^{-3}.
b. 3.4×10^2, which is also 340, is smaller than 1250.
c. 0.000 000 4, which is also 4×10^{-7}, is smaller than 5.0×10^2.
d. 2.50×10^2, which is also 250, is smaller than 4×10^5 or 400 000.

1.29 $\dfrac{120 \text{ g ethylene glycol}}{450 \text{ g liquid}} \times 100\% = 27\% \text{ ethylene glycol}$

1.30 $\dfrac{1.5 \text{ g ethylene glycol}}{1000 \text{ g body mass}} \times 100\% = 0.15\% \text{ ethylene glycol}$

1.31 No. All of these ingredients are chemicals.

1.32 No. All of these ingredients are chemicals.

1.33 Yes. Sherlock's investigation includes making observations (gathering data), formulating a hypothesis, testing the hypothesis, and modifying it until one of the hypotheses is validated.

1.34 Sherlock meant that you should not propose a theory until you have data from experiments and observations.

1.35 **a.** When two negative numbers are added, the answer has a negative sign.
b. When a positive and negative number are multiplied, the answer has a negative sign.

1.36 **a.** When a negative number is subtracted from a positive number, the answer has a positive sign.
b. When two negative numbers are divided, the answer has a positive sign.

1.37 **a.** Describing the appearance of a patient is an observation.
b. Formulating a reason for the extinction of dinosaurs is a hypothesis.
c. Measuring the completion time of a race is an observation.

1.38 **a.** Measuring the composition of a sample is an observation.
b. Recording a change in a sample is an observation.
c. Formulating a reason as to why a phenomenon has happened is a hypothesis.

1.39 If experimental results do not support your hypothesis, you should:
b. modify your hypothesis.
c. do more experiments.

1.40 A hypothesis is confirmed when:
b. many experiments validate the hypothesis.

1.41 A successful study plan would include:
b. working the *Sample Problems* as you go through a chapter.
c. self-testing.

1.42 A successful study plan would include:
b. forming a study group and discussing the problems together.
c. working problems in a notebook for easy reference.

1.43 **a.** $4 \times (-8) = -32$
b. $-12 - 48 = -12 + (-48) = -60$
c. $\dfrac{-168}{-4} = 42$

1.44 **a.** $-95 - (-11) = -95 + 11 = -84$
b. $\dfrac{152}{-19} = -8$
c. $4 - 56 = 4 + (-56) = -52$

1.45 total number of gumdrops = 16 orange + 8 yellow + 16 black = 40 gumdrops
a. $\dfrac{8 \text{ yellow gumdrops}}{40 \text{ total gumdrops}} \times 100\% = 20\%$ yellow gumdrops
b. $\dfrac{16 \text{ black gumdrops}}{40 \text{ total gumdrops}} \times 100\% = 40\%$ black gumdrops

1.46 total number of students = 12 As + 18 Bs + 20 Cs = 50 students
a. $\dfrac{18 \text{ Bs}}{50 \text{ total students}} \times 100\% = 36\%$ Bs
b. $\dfrac{20 \text{ Cs}}{50 \text{ total students}} \times 100\% = 40\%$ Cs

1.47 **a.** Move the decimal point five places to the left to give 1.2×10^{5}.
b. Move the decimal point seven places to the right to give 3.4×10^{-7}.
c. Move the decimal point two places to the right to give 6.6×10^{-2}.
d. Move the decimal point three places to the left to give 2.7×10^{3}.

1.48 **a.** Move the decimal point three places to the right to give 4.2×10^{-3}.
b. Move the decimal point two places to the left to give 3.1×10^{2}.
c. Move the decimal point eight places to the left to give 8.9×10^{8}.
d. Move the decimal point eight places to the right to give 5.6×10^{-8}.

1.49 **a.** An observation is a description or measurement of a natural phenomenon.
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1.53 **a.**
$$\begin{aligned} 2x + 5 &= 41 \\ 2x + \cancel{5} - \cancel{5} &= 41 - 5 \\ 2x &= 36 \\ \frac{\cancel{2}x}{\cancel{2}} &= \frac{36}{2} \\ x &= 18 \end{aligned}$$

b.
$$\begin{aligned} \frac{5x}{3} &= 40 \\ \cancel{3}\left(\frac{5x}{\cancel{3}}\right) &= 3(40) \\ 5x &= 120 \\ \frac{\cancel{5}x}{\cancel{5}} &= \frac{120}{5} \\ x &= 24 \end{aligned}$$

1.54 **a.**
$$\begin{aligned} 3z - (-6) &= 12 \\ 3z + 6 &= 12 \\ 3z + \cancel{6} - \cancel{6} &= 12 - 6 \\ 3z &= 6 \\ \frac{\cancel{3}z}{\cancel{3}} &= \frac{6}{3} \\ z &= 2 \end{aligned}$$

b.
$$\frac{4z}{-12} = -8$$
$$\cancel{-12}\left(\frac{4z}{\cancel{-12}}\right) = -12(-8)$$
$$4z = 96$$
$$\frac{\cancel{4}z}{\cancel{4}} = \frac{96}{4}$$
$$z = 24$$

1.55 **a.** The graph shows the relationship between the solubility of carbon dioxide in water and temperature.
b. The vertical axis measures the solubility of carbon dioxide in water (g CO_2/100 g water).
c. The values on the vertical axis range from 0 to 0.35 g CO_2/100 g water.
d. As temperature increases, the solubility of carbon dioxide in water decreases.

1.56 **a.** The horizontal axis measures temperature, in °C.
b. The values on the horizontal axis range from 0 °C to 60 °C.
c. At 25 °C, the solubility of carbon dioxide in water is about 0.17 g CO_2/100 g water.
d. Carbon dioxide has a solubility of 0.20 g CO_2/100 g water at a temperature of about 16 °C.