CHAPTER

1

Introduction to Chemistry

Section 1.1 *Evolution of Chemistry*

2. Thales stated *water* was the single element that composed earth, air, and space.

4. Aristotle stated *air*, *earth*, *fire*, *water*, and *ether* were five basic elements responsible for everything in nature.

6. Step 2 of the scientific method is to *analyze the data* and *propose a tentative hypothesis* to explain the experimental observations.

8. *Robert Boyle* is generally considered the founder of the scientific method.

10. A *hypothesis* is an initial proposal that is tentative, whereas a *theory* is a proposal that has been extensively tested and verified.

12. (a) is a *natural law* because the relationship is stated as an equation.
    (b) is a *scientific theory* because the number of molecules cannot be counted.
    (c) is a *natural law* because gas temperature and pressure can be measured.
    (d) is a *scientific theory* because it is a model that explains the atom.

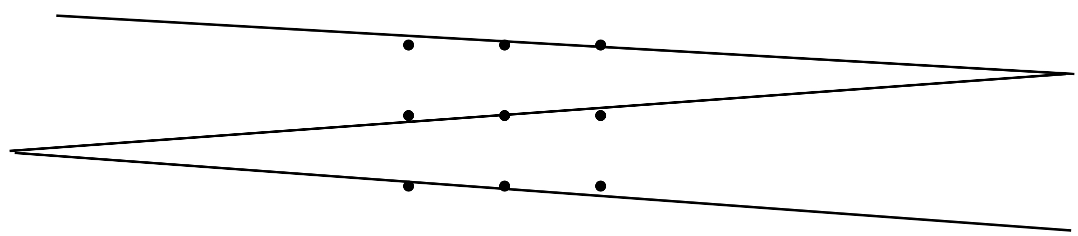
Section 1.2 *Modern Chemistry*

14. *Antoine Lavoisier* is considered the founder of modern chemistry.

16. *Agriculture* and *medicine* are industries in which chemistry plays a crucial role. Other industries in which chemistry plays an important role include the *pharmaceutical*, *electronics*, *paper*, *construction*, and *petrochemical* industries.

Section 1.3 *Learning Chemistry*

18. A solution to the nine-dot problem using three straight lines is shown below; the unconscious assumption regards the angle of the lines and the size of the dots.



Challenge Exercises

20. By staring at the point where the blocks intersect, we can "flip" the image and view the blocks as stacking upward, or stacking downward.

CHAPTER

PSS

Prerequisite Science Skills

Section PSS.1 *Measurements*

2. The diameter of a 5¢ nickel coin is approximately 2 cm.

4.

	Unit	Quantity		Unit	Quantity
(a)	meter	length	(b)	kilogram	mass
(c)	liter	volume	(d)	millisecond	time

6. (b) 2.05 cm and (c) 2.00 cm each have an uncertainty of ± 0.05 cm.

8. (d) 25.000 g has a mass uncertainty of ± 0.001 g; thus, an electronic balance.

10. (b) 25.0 mL and (c) 25.5 mL each have an uncertainty of ± 0.5 mL.

Section PSS.2 *Significant Digits*

12.

	Measurement	Significant Digits
(a)	500 cm	1 significant digit
(b)	5000 g	1 significant digit
(c)	0.05 mL	1 significant digit
(d)	0.005 s	1 significant digit

14.

	Measurement	Significant Digits
(a)	5.0 cm	2 significant digits
(b)	5.05 g	3 significant digits
(c)	5.02×10^{-1} mL	3 significant digits
(d)	1.0×10^{-2} s	2 significant digits

16.

	Measurement	Significant Digits
(a)	0.5 cm	1 significant digit
(b)	0.50 g	2 significant digits
(c)	1.00×10^{1} mL	3 significant digits
(d)	1.000×10^{3} s	4 significant digits

Section PSS.3 *Rounding Off Nonsignificant Digits*

18.

	Example	Rounded Off
(a)	20.155	20.2
(b)	0.204 500	0.205
(c)	2055	2060 (2.06×10^3)
(d)	0.2065	0.207

20.

	Example	Rounded Off
(a)	1.454×10^1	1.45×10^1
(b)	1.455×10^2	1.46×10^2
(c)	1.508×10^{-3}	1.51×10^{-3}
(d)	1.503×10^{-4}	1.50×10^{-4}

Section PSS.4 *Adding and Subtracting Measurements*

22. (a) 0.4 g + 0.44 g + 0.444 g = 1.284 g *rounds to* 1.3 g
    (b) 15.5 g + 7.50 g + 0.050 g = 23.050 g *rounds to* 23.1 g

24. (a) 242.197 g – 175 g = 67.197 g *rounds to* 67 g
    (b) 27.55 g – 14.545 g = 13.005 g *rounds to* 13.01 g

Section PSS.5 *Multiplying and Dividing Measurements*

26. (a) $3.65 \text{ cm} \times 2.10 \text{ cm} = 7.665 \text{ cm}^2$ *rounds to* 7.67 cm^2
    (b) $8.75 \text{ cm} \times 1.15 \text{ cm} = 10.0625 \text{ cm}^2$ *rounds to* 10.1 cm^2
    (c) $16.5 \text{ cm} \times 1.7 \text{ cm} = 28.05 \text{ cm}^2$ *rounds to* 28 cm^2
    (d) $21.1 \text{ cm} \times 20 \text{ cm} = 422 \text{ cm}^2$ *rounds to* 400 cm^2

28. (a) $\frac{26.0 \text{ cm}^2}{10.1 \text{ cm}} = 2.5743 \text{ cm}$ *rounds to* 2.57 cm
    (b) $\frac{9.95 \text{ cm}^3}{0.15 \text{ cm}^2} = 66.333 \text{ cm}$ *rounds to* 66 cm
    (c) $\frac{131.78 \text{ cm}^3}{19.25 \text{ cm}} = 6.8457 \text{ cm}^2$ *rounds to* 6.846 cm^2
    (d) $\frac{131.78 \text{ cm}^3}{19.2 \text{ cm}} = 6.8635 \text{ cm}^2$ *rounds to* 6.86 cm^2

Section PSS.6 *Exponential Numbers*

30. (a) $10 \times 10 \times 10 \times 10 = 10^4$

    (b) $\frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} = (\frac{1}{10})^4 = 10^{-4}$

32. (a) $3 \times 3 \times 3 \times 3 = 3^4$

(b) $\frac{1}{3} \times \frac{1}{3} \times \frac{1}{3} \times \frac{1}{3} = (\frac{1}{3})^4 = 3^{-4}$

34.

	Number	Scientific Notation
(a)	1×10^{12}	1,000,000,000,000
(b)	1×10^{-22}	0.000 000 000 000 000 000 000 1

36.

	Number	Scientific Notation
(a)	100,000,000,000,000,000	1×10^{17}
(b)	0.000 000 000 000 001	1×10^{-15}

38.

	Scientific Notation	Number
(a)	1×10^{0}	1
(b)	1×10^{-10}	0.000 000 000 1

Section PSS.7 *Scientific Notation*

40.

	Ordinary Number	Scientific Notation
(a)	1,010,000,000,000,000	1.01×10^{15}
(b)	0.000 000 000 000 456	4.56×10^{-13}
(c)	94,500,000,000,000,000	9.45×10^{16}
(d)	0.000 000 000 000 000 019 50	1.950×10^{-17}

42. 2.69×10^{19} helium atoms

44. 6.64×10^{-24} g/helium atom

General Exercises

46. 10.00 mL (± 0.01 mL)

48. 3.00×10^{8} meters per second
The velocity must be expressed in scientific notation because the rounded value, 300,000,000 meters per second, has only one significant digit.

50. 126.457 g + 131.60 g = 258.057 g *rounds to* 258.06 g

52.

	Exponential Number	Scientific Notation
(a)	0.170×10^{2}	1.70×10^{1}
(b)	0.00350×10^{-1}	3.50×10^{-4}

Challenge Exercises

54. Mass of a neutron $= 1.6749 \times 10^{-24}$ g

Mass of a proton $= 1.6726 \times 10^{-24}$ g

Mass difference: $(1.6749 \times 10^{-24}\text{ g}) - (1.6726 \times 10^{-24}\text{ g}) = 2.3 \times 10^{-27}$ g

56. 1 metric ton = 2200 lb $= 2.200 \times 10^{3}$ lb

1 English ton = 2000 lb $= 2.000 \times 10^{3}$ lb

Mass difference: $2.200 \times 10^{3}\text{ lb} - 2.000 \times 10^{3}\text{ lb} = 0.200 \times 10^{3}\text{ lb} = 2.00 \times 10^{2}$ lb