Instructor's Manual

Chemistry for Today

General, Organic, and Biochemistry

NINTH EDITION

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Chapter 1: Matter, Measurements, and Calculations

CHAPTER OUTLINE

LEARNING OBJECTIVES/ASSESSMENT

When you have completed your study of this chapter, you should be able to:

1. Explain what matter is. (Section 1.1; Exercise 1.2)
2. Explain differences between the terms *physical* and *chemical* as applied to:
    a. Properties of matter (Section 1.2; Exercises 1.10 b & c)
    b. Changes in matter (Section 1.2; Exercises 1.8 a & b)
3. Describe matter in terms of the accepted scientific model. (Section 1.3; Exercise 1.12)
4. On the basis of observation or information given to you, classify matter into the correct category of each of the following pairs:
    a. Heterogeneous or homogeneous (Section 1.4; Exercise 1.22)
    b. Solution or pure substance (Section 1.4; Exercise 1.24)
    c. Element or compound (Section 1.4; Exercise 1.18)
5. Recognize the use of measurement units in everyday activities. (Section 1.5; Exercise 1.28)
6. Recognize units of the metric system, and convert measurements done using the metric system into related units. (Section 1.6; Exercises 1.30 and 1.40)
7. Express numbers using scientific notation, and do calculations with numbers expressed in scientific notation. (Section 1.7; Exercises 1.48 and 1.60)
8. Express the results of measurements and calculations using the correct number of significant figures. (Section 1.8; Exercises 1.64 and 1.66)
9. Use the factor-unit method to solve numerical problems. (Section 1.9; Exercise 1.82)
10. Do calculations involving percentages. (Section 1.10; Exercise 1.92)
11. Do calculations involving densities. (Section 1.11; Exercise 1.98)

LECTURE HINTS AND SUGGESTIONS

1. When describing chemistry as the "central science," explain how everything around us is somehow related to chemistry. Look around the classroom and point out things which are a result of the study of chemistry; such as the plastic materials which make up part of the furniture, the paint on the walls, the clothing that we have on, the paper that we write on, the ink that we write with, and even the reactions which take place in our bodies which keep us alive.

2. Stress that a pure substance contains only one kind of basic building block or one kind of constituent particle. Every constituent particle in a pure substance is the same. If there are two or more kinds of constituent particles present, it is a mixture. Sugar has sugar molecules; water has water molecules; and sugar water has both sugar molecules and water molecules.

3. Emphasize that an important characteristic of a pure substance is a constant composition. Give some simple examples, such as water or salt, which when free of other substances, always have the same composition regardless of source. Simple common solutions such as salt water can be used as examples of mixtures. Also, stress that a mixture may have a varying composition. For example, salt

water may contain a very small amount of salt or a lot of salt. Salt water is a mixture. If it is left out in an open dish, the water will evaporate (a physical process) leaving behind the salt.

4. Students sometimes miss the whole point behind significant figures. The most important point to convey is that all measured data have some uncertainty associated with them that is inherent in the measuring device. A simple demonstration is to have students measure the classroom width using a rope knotted at about one meter intervals, a meter stick and a tape measure. Note: Since the knots on the rope are not numbered, students need to manually count them. Have three students perform the same counting. The results often differ significantly for a large classroom.

SOLUTIONS FOR THE END OF CHAPTER EXERCISES

WHAT IS MATTER? (SECTION 1.1)

1.1 If a heavy steel ball is suspended by a thin wire and hit from the side with a hammer on the moon, the heavy steel ball will hardly move, just like on earth. This experiment depends only on the mass of the ball and the hammer, not their weights.

☑1.2 All matter occupies space and has mass. Mass is a measurement of the amount of matter in an object. The mass of an object is constant regardless of where the mass is measured. Weight is a measurement of the gravitational force acting on an object. The weight of an object will change with gravity; therefore, the weight of an object will be different at different altitudes and on different planets.

1.3 To prove to a doubter that air is matter, precisely weigh a deflated balloon, then inflate it and weigh it again. The mass of the inflated balloon will be greater than the mass of the deflated balloon because the air in the inflated balloon has mass. The volume of the air is also clearly evident in the increased size of the balloon.

1.4 The distance you can throw a bowling ball will change more than the distance you can roll a bowling ball on a flat, smooth surface. When throwing a ball, gravity pulls the ball toward the ground and air resistance slows its decent. The gravitational force on the moon is approximately 1/6th the gravitational force that is present on the earth; therefore, when throwing a ball on the moon, you should be able to throw it further than you can on earth. The moon does not have air resistance. When rolling a ball, friction helps to slow down the ball. If the flat, smooth surface is the same on the earth and the moon, the amount of friction should remain constant.

1.5
a. If you were transported from a deep mine to the top of a tall mountain, your mass would not be changed by the move because mass is independent of gravity.
b. If you were transported from a deep mine to the top of a tall mountain, your weight would decrease because weight depends on gravity and gravity decreases with distance from the earth's center. A mountaintop is further from the earth's center than a deep mine; therefore, your weight will be less on the mountaintop.

1.6 The attractive force of gravity for objects near the earth's surface increases as you get closer to the center of the earth (Exercise 1.5). If the earth bulges at the equator, the people at the equator are further from the center of the earth than people at the North Pole. If two people with the same mass were weighed at the equator and at the North Pole, the person at the equator would weigh less than the person at the North Pole because the gravitational force at the North Pole is stronger than the gravitational force at the equator.

PROPERTIES AND CHANGES (SECTION 1.2)

1.7
a. The plum's color, smell, and taste have changed. This was a change in composition; therefore, it is a **chemical change**.
b. The water vapor can be condensed into liquid water and its properties will not have changed by the boiling. The composition of the water has not changed by boiling; therefore, it is a **physical change**.
c. The glass pieces still have the same chemical composition as the original glass window. This was a change that did not involve composition; therefore, it is a **physical change**.
d. The food is broken down into components that can be used by the body. This is a change that involves composition; therefore, it is a **chemical change**.

1.8
☑a. The two pieces of the stick still have the same chemical composition as the original stick. This was a change that did not involve composition; therefore, it is a **physical change**.
☑b. As the candle burns, it produces carbon dioxide, water, soot, and other products. This is a change that involves composition; therefore, it is a **chemical change**.
c. The pieces of rock salt have the same chemical composition as the original larger piece of rock salt. This was a change that did not involve composition; therefore, it is a **physical change**.
d. Many tree leaves are green in the spring and summer because of the green chlorophyll that is used in photosynthesis to produce energy for the tree. During these seasons, the tree stores the extra energy so that in autumn when the days grow shorter, the chlorophyll is no longer needed. As the leaves in the cell stop producing chlorophyll, the other colors present in the leaves become more visible. This change involves composition; therefore, it is a **chemical change**.

1.9
a. The melting point of a material is a **physical property** because the composition does not change during a phase change.
b. The flammability of a substance is a **chemical property** because the composition of the substance is changed by burning it in air.
c. The lack of corrosion of a material is a **chemical property** because a corroded material would have a different chemical composition than the original material. Attempting to change the chemical composition of a material is a test of a chemical property regardless of whether the attempt is successful.
d. The weight and volume of a material are **physical properties** because the composition does not change by weighing or measuring the material.
e. The ability of a material to neutralize another material is a **chemical property** because the composition of both the materials changes as they react.

1.10
a. The phase of matter at room temperature is a **physical property** because the composition does not change while making this observation.
☑b. The reaction between two substances is a **chemical property** because the composition of the products differs from the reactants. The products for the reaction between sodium metal and water are sodium hydroxide and hydrogen gas. (Note: Predicting the products for this type of chemical reaction is covered in Section 9.6.)
☑c. Freezing point is a **physical property** because the composition does not change while making this observation.
d. The inability of a material to form new products by rusting is a **chemical property** because rust would have a different chemical composition than gold. Attempting to

change the chemical composition of a material is a test of a chemical property regardless of whether the attempt is successful.

e. The color of a substance is a **physical property** because the composition does not change while making this observation.

A MODEL OF MATTER (SECTION 1.3)

1.11 The alcohol is reversibly changed from a liquid to a solid and back again. The alcohol is the same material regardless of state. Changes in phase are **physical changes**.

☑1.12 a. Yes, the succinic acid molecules have been changed by the process. The molecules of succinic acid released at least one atom each in the form of a gas. Without those atoms, the molecules cannot be succinic acid molecules. Also, if they were still succinic acid molecules, the melting point of the remaining solid would still be 182°C.

b. No, the white solid that remains after heating is not succinic acid. The melting point of succinic acid is 182°C, but the melting point of this new solid is not 182°C.

c. The succinic acid molecules contain more atoms than the molecules of the white solid produced by this process. Some of the atoms that were originally part of the succinic acid molecules are given off as a gas. That leaves fewer atoms to be a part of the molecules of new white solid.

d. Succinic acid is **heteroatomic**. Some of the atoms were able to leave the succinic acid molecule in the form of a gas. Other atoms remained as part of a new molecule. If all of the atoms were the same type, they would have all turned into a gas or they would have all remained as a solid.

1.13 a. Yes, the white solid particles have different properties than the red solid; therefore, the molecules of the phosphorus have been changed by the process of burning.

b. Yes, the white solid particles have different properties than the red solid; therefore, the collected white solid is a different substance than the phosphorus.

c. The molecules of the white solid contain a substance in addition to phosphorus (oxygen). The elemental phosphorus contained only phosphorus atoms, but the white solid must contain more kinds of atoms than phosphorus because the properties changed by burning; therefore, the molecules of the white solid should be larger.

d. The molecules of the collected white solid are **heteroatomic** because they contain more than one type of atom.

1.14 Carbon dioxide is **heteroatomic**. If oxygen and carbon atoms react to form one product, then carbon dioxide must contain these two types of atoms.

1.15 Hydrogen peroxide is **heteroatomic**. If water (which contains hydrogen and oxygen atoms) and oxygen gas can be produced from hydrogen peroxide, then hydrogen peroxide must contain both hydrogen and oxygen atoms.

1.16 Water is **heteroatomic**. If breaking water apart into its components produces both hydrogen gas and oxygen gas, then water must contain two types of atoms.

1.17 Methane gas is **heteroatomic**. If burning methane in oxygen gas produces water (which contains hydrogen and oxygen atoms) and carbon dioxide (which contains carbon and oxygen atoms), then methane must contain hydrogen and carbon atoms (assuming all the oxygen atoms in the products came from the oxygen gas).

CLASSIFYING MATTER (SECTION 1.4)

☑1.18
a. Substance A is a **compound** because it is composed of molecules that contain more than one type of atom.
b. Substance D is an **element** because it is composed of molecules that contain only one type of atom.
c. Substance E is a **compound** because it is a pure substance that can break down into at least two different materials. Substances G and J **cannot be classified** because no tests were performed on them.

1.19
a. Substance L is a compound. It is formed by combining two elements.
b. Substances M and Q cannot be classified. Without further testing it is impossible to tell if the substances are elements or compounds.
c. Substance X cannot be classified. The absence of a change is not conclusive evidence that a substance is an element or a compound.

1.20
a. Substance R might appear to be an element based on the tests performed. It has not decomposed into any simpler substances based on these tests; however, this is not an exhaustive list of tests that could be performed on substance R. Substance R **cannot be classified** as an element or a compound based on the information given.
b. Substance T is a **compound**. It is composed of at least two different elements because it produced two different substances on heating.
c. The solid left in part b **cannot be classified** as an element or a compound. No tests have been performed on it.

1.21 Early scientists incorrectly classified calcium oxide (lime) as an element for a number of years. It is possible this mistake in classification was made because calcium oxide was the product of decomposing limestone (calcium carbonate) and it was difficult to further decompose the lime into the elements of calcium and oxygen.

☑1.22

a.	A gold chain	It is **homogeneous** because it has the same composition throughout.
b.	Liquid eye drops	It is **homogeneous** because it has the same composition throughout.
c.	Chunky peanut butter	It is **heterogeneous** because it does not have the same composition throughout (peanut chunk vs. smooth regions).
d.	A slice of watermelon	It is **heterogeneous** because it does not have the same composition throughout (rind, meat, and seeds).
e.	Cooking oil	It is **homogeneous** because it has the same composition throughout.
f.	Italian salad dressing	It is **heterogeneous** because it does not have the same composition throughout (oil, vinegar, and seasonings).
g.	Window glass	It is **homogeneous** because it has the same composition throughout.

1.23

a.	Muddy flood water	It is **heterogeneous** because it does not have the same composition throughout (concentration of mud/debris depends on water depth).

	b.	Gelatin dessert	It is **homogeneous** because it has the same composition throughout.
	c.	Normal urine	It is **homogeneous** because it has the same composition throughout.
	d.	Smog-filled air	It is **heterogeneous** because it does not have the same composition throughout (concentration of smog, oxygen, other gases depends on the altitude).
	e.	An apple	It is **heterogeneous** because it does not have the same composition throughout (skin, meat, seeds).
	f.	Mouthwash	It is **homogeneous** because it has the same composition throughout.
	g.	Petroleum jelly	It is **homogeneous** because it has the same composition throughout.

☑1.24	a.	A pure gold chain	The chain is only made of gold; therefore, it is a **pure substance**.
	b.	Liquid eye drops	This is a **solution** because it contains saline (water and sodium chloride) as well as other substances.
	e.	Cooking oil	It can be a **solution** or a **pure substance** depending on the oil. Some oils only contain a single compound (pure substances); however, most oils are a mixture of several different compounds (solution).
	g.	Window glass	It is a **solution** because it contains a mixture of silicon dioxide and other components like iron.

1.25	b.	Gelatin dessert	This is a **solution** because it contains many substances.
	c.	Normal urine	This is a **solution** because it contains many substances (urea, water, dissolved salts, etc.).
	f.	Mouthwash	This is a **solution** because it contains many substances.
	g.	Petroleum jelly	This is a **solution** because it contains many substances.

MEASUREMENT UNITS (SECTION 1.5)

1.26 Modern society is complex and interdependent. Accomplishing projects like building a bridge, constructing a house, or machining an engine may require many different people to participate. Some people design the project, others supply the necessary materials, and yet another group does the construction. In order for the project to be successful, all of these people need a common language of measurement. Measurement is also important for giving directions, keeping track of the time people work, and keeping indoor environments at a comfortable temperature and pressure.

1.27 In the distant past, 1 in. was defined as the length resulting from laying a specific number of grain kernels such as corn in a row. The size of 1 in. would vary in this system because the size of individual kernels as well as the tightness of the packing would vary. The unit obtained by this system would not be consistent in all situations.

☑1.28 The amount of weight that a horse could carry or drag might have been measured in stones. It could also be used to measure people or other items in the 50 ‑ 500 pound range. It is likely that a large stone was picked as the standard weight for the “stone” unit. Stones may have also been used as counterweights on an old ‑ fashioned set of balances.

THE METRIC SYSTEM (SECTION 1.6)

1.29 The metric units are (b) kilometers and (c) liters. The English units are (a) grains, (d) minutes and seconds, (e) acres, and (f) degrees Fahrenheit.

☑1.30 The metric units are (a) degrees Celsius, (b) liters, (d) milligrams, and (f) seconds. The English units are (c) feet and (e) quarts.

1.31 Liters are a metric unit that could replace the English unit gallon in the measurement of the amount of gasoline in a tank. Joules are a metric unit that could replace the English unit BTU in the measurement of the amount of heat used to warm some water. Meters are a metric unit that could replace the English unit feet in the measurement of the diameter of a circular table.

1.32 Meters are a metric unit that could replace the English unit feet in the measurement of the ceiling height. Liters are a metric unit that could replace the English unit quarts in the measurement of the volume of a cooking pot.

1.33

a. $12\ \cancel{\text{megabytes}}\left(\frac{10^6\ \text{bytes}}{1\ \cancel{\text{megabyte}}}\right) = 1.2\times10^7\ \text{bytes}$

b. $10.\ \cancel{\text{km}}\left(\frac{1000\ \text{m}}{1\ \cancel{\text{km}}}\right) = 1.0\times10^4\ \text{m}$

c. $0.1\ \cancel{\text{mg}}\left(\frac{10^{-3}\ \text{g}}{1\ \cancel{\text{mg}}}\right) = 1\times10^{-4}\ \text{g}$

d. $1\ \cancel{\mu\text{m}}\left(\frac{10^{-6}\ \text{m}}{1\ \cancel{\mu\text{m}}}\right) = 1\times10^{-6}\ \text{m}$

1.34

a. $1.00\ \cancel{\text{L}}\left(\frac{1\ \mu\text{L}}{10^{-6}\ \cancel{\text{L}}}\right) = 1.00\times10^6\ \mu\text{L}$

b. $75\ \cancel{\text{kilowatts}}\left(\frac{1000\ \text{watts}}{1\ \cancel{\text{kilowatt}}}\right) = 7.5\times10^4\ \text{watts}$

c. $15\ \cancel{\text{megahertz}}\left(\frac{10^6\ \text{hertz}}{1\ \cancel{\text{megahertz}}}\right) = 1.5\times10^7\ \text{hertz}$

d. $200.\ \cancel{\text{picometers}}\left(\frac{10^{-12}\ \text{meters}}{1\ \cancel{\text{picometer}}}\right) = 2.00\times10^{-10}\ \text{meters}$

1.35 $1\ \cancel{\text{in}}\left(\frac{2.54\ \cancel{\text{cm}}}{1\ \cancel{\text{in}}}\right)\left(\frac{10^{-2}\ \cancel{\text{m}}}{1\ \cancel{\text{cm}}}\right)\left(\frac{1\ \text{mm}}{10^{-3}\ \cancel{\text{m}}}\right) = 2.54\times10^1\ \text{mm}$ or $1\ \cancel{\text{in}}\left(\frac{2.54\ \cancel{\text{cm}}}{1\ \cancel{\text{in}}}\right)\left(\frac{10^{-2}\ \text{m}}{1\ \cancel{\text{cm}}}\right) = 2.54\times10^{-2}\ \text{m}$

1.36 $1\ \cancel{\text{cup}}\left(\frac{240\ \cancel{\text{mL}}}{1\ \cancel{\text{cup}}}\right)\left(\frac{1\ \text{L}}{1000\ \cancel{\text{mL}}}\right) = 0.240\ \text{L}$ or $1\ \cancel{\text{cup}}\left(\frac{240\ \cancel{\text{mL}}}{1\ \cancel{\text{cup}}}\right)\left(\frac{1\ \text{cm}^3}{1\ \cancel{\text{mL}}}\right) = 240\ \text{cm}^3$

1.37 $25\ \cancel{\text{km}}\left(\frac{0.621\ \text{mi}}{1\ \cancel{\text{km}}}\right) = 16\ \text{mi}$

1.38 $4.0\ \cancel{kg}\left(\dfrac{2.20\,\text{lbs.}}{1\ \cancel{kg}}\right) = 8.8\,\text{lbs.}$

1.39 a. 1 cm = 0.394 in., so an inch is longer.

b. $1\ \cancel{qt}\left(\dfrac{1\ \cancel{L}}{1.057\ \cancel{qt}}\right)\left(\dfrac{1000\text{mL}}{1\ \cancel{L}}\right) = 946.1\text{mL}$

c. $1\ \cancel{oz}\left(\dfrac{1\ \text{g}}{0.035\ \cancel{oz}}\right) = 29\ \text{g}$

☑1.40 a. $1\,\text{m} = 1.094\,\text{yd, so:}\ \ 1\,\text{m} - 1\,\text{yd} = 1.094\,\text{yd} - 1\,\text{yd} = 0.094\ \cancel{yd}\left(\dfrac{3\ \cancel{ft}}{1\ \cancel{yd}}\right)\left(\dfrac{12\,\text{in}}{1\ \cancel{ft}}\right) = 3.4\,\text{in}$

b. The size of 1°C is the same as 1 K; therefore, a change of 65°C is also a change of 65 K.

c. $5\ \cancel{lbs.}\left(\dfrac{1\,\text{kg}}{2.20\ \cancel{lbs.}}\right) = 2.27\,\text{kg} = 2\,\text{kg with significant figures}$

1.41 a. $A = \pi(12.5\ \text{m})^2 = 490.625\ \text{m}^2 = 491\ \text{m}^2\ \text{ with significant figures}$

$\text{Area} = \text{length} \times \text{width} = 5.0\ \text{m} \times 2.8\ \text{m} = 14\ \text{m}^2$

b. $\text{Volume} = \text{length} \times \text{width} \times \text{height} = 5.0\ \text{m} \times 2.8\ \text{m} \times 2.1\ \text{m} = 29.4\ \text{m}^3$

$= 29\ \text{m}^3\ \text{ with significant figures}$

c. $\text{Area} = \dfrac{(15\,\text{cm})(25\,\text{cm})}{2} = 187.5\,\text{cm}^2 = 1.9 \times 10^2\ \text{cm}^2\ \text{with significant figures}$

1.42 a. $1.0\ \cancel{cm^3}\left(\dfrac{1\ \cancel{dm^3}}{1000\ \cancel{cm^3}}\right)\left(\dfrac{1\,\text{kg}}{1.0\ \cancel{dm^3}}\right) = 1.0 \times 10^{-3}\ \text{kg}\quad \text{or}$

$1.0\ \cancel{cm^3}\left(\dfrac{1\ \cancel{dm^3}}{1000\ \cancel{cm^3}}\right)\left(\dfrac{1\ \cancel{kg}}{1.0\ \cancel{dm^3}}\right)\left(\dfrac{1000\,\text{g}}{1\ \cancel{kg}}\right) = 1.0\,\text{g}$

b. $2.0\ \cancel{L}\left(\dfrac{1.057\ \cancel{qt}}{1\ \cancel{L}}\right)\left(\dfrac{32\,\text{fl oz}}{1\ \cancel{qt}}\right) = 68\,\text{fl oz}$

c. $5\ \cancel{grain}\left(\dfrac{1\,\text{mg}}{0.015\ \cancel{grain}}\right) = 333\,\text{mg} = 3 \times 10^2\ \text{mg with significant figures}$

1.43 $°\text{C} = \tfrac{5}{9}(°\text{F} - 32)$ $\qquad °\text{C} = \tfrac{5}{9}(23°\text{F} - 32) = -5°\text{C}$

$\text{K} = °\text{C} + 273$ $\qquad \text{K} = \tfrac{5}{9}(23°\text{F} - 32) + 273 = 268\ \text{K}$

1.44 $°\text{F} = \tfrac{9}{5}(°\text{C}) + 32$ $\qquad °\text{F} = \tfrac{9}{5}(36.1°\text{C}) + 32 = 97.0°\text{F}$ $\qquad °\text{F} = \tfrac{9}{5}(37.2°\text{C}) + 32 = 99.0°\text{F}$

$$4500.\,\cancel{\text{kcal}}\left(\frac{4184\text{ J}}{1\,\cancel{\text{kcal}}}\right) = 18828000\text{ J} = 1.883\times10^{7}\text{ J with significant figures}$$

1.45

$$4500.\,\cancel{\text{kcal}}\left(\frac{3.97\text{ BTU}}{1\,\cancel{\text{kcal}}}\right) = 17865\text{ BTU} = 1.787\times10^{4}\text{ BTU with significant figures}$$

LARGE AND SMALL NUMBERS (SECTION 1.7)

1.46
a. 02.7×10^{-3} Improper form because no leading zero is necessary. (2.7×10^{-3})
b. 4.1×10^{2} Correct.
c. 71.9×10^{-6} Improper form because only one digit should be to the left of the decimal point. (7.19×10^{-5})
d. 10^{3} Improper form because a nonexponential term should be written before the exponential term. (1×10^{3})
e. 0.0405×10^{-2} Improper form because one nonzero digit should be to the left of the decimal point. (4.05×10^{-4})
f. 0.119 Improper form because one nonzero digit should be to the left of the decimal point and an exponential term should be to the right of the nonexponential term. (1.19×10^{-1})

1.47
a. 4.2×10^{3} Correct.
b. 6.8^{4} Improper form because the "x 10" factor is missing. (6.8×10^{4})
c. 202×10^{-3} Improper form because only one digit should be to the left of the decimal point. (2.02×10^{-3})
d. 0.026×10^{-2} Improper form because only one non-zero digit should be to the left of the decimal point. (2.6×10^{-2})
e. 10^{-2} Improper form because a nonexponential term should be written before the exponential term. (1×10^{-2})
f. 74.5×10^{5} Improper form because only one digit should be to the left of the decimal point. (7.45×10^{5})

☑1.48
a. 14 thousand = 14,000 = 1.4×10^{4}
b. 365 3.65×10^{2}
c. 0.00204 2.04×10^{-3}
d. 461.8 4.618×10^{2}
e. 0.00100 1.00×10^{-3}
f. 9.11 hundred = 9.11 x 100 = 9.11×10^{2}

1.49
a. Three hundred = 300 = 3×10^{2}
b. 4003 4.003×10^{3}
c. 0.682 6.82×10^{-1}
d. 91.86 9.186×10^{1}
e. 6000 6×10^{3}
f. 400 4×10^{2}

1.50
a. 186 thousand mi/s 186 x 1000 = 1.86×10^{5} mi/s
b. 1100 million km/h 1100 x 1,000,000 = 1.1×10^{9} km/h

1.51 0.0106 cm = 1.06×10^{-2} cm
0.0042 in. = 4.2×10^{-3} in.

1.52 0.000 000 000 000 000 000 000 105 g
The decimal point has been moved 22 places to the left. This places 21 zeros to the right of the decimal point and before the numbers 105 g.

1.53 602 000 000 000 000 000 000 000 hydrogen molecules
The decimal point has been moved 23 places to the right.

1.54
a. $(8.2 \times 10^{-3})(1.1 \times 10^{-2})$ $= 9.02 \times 10^{-5}$ $= 9.0 \times 10^{-5}$ with significant figures
b. $(2.7 \times 10^{2})(5.1 \times 10^{4})$ $= 1.377 \times 10^{7}$ $= 1.4 \times 10^{7}$ with significant figures
c. $(3.3 \times 10^{-4})(2.3 \times 10^{2})$ $= 7.59 \times 10^{-2}$ $= 7.6 \times 10^{-2}$ with significant figures
d. $(9.2 \times 10^{-4})(2.1 \times 10^{4})$ $= 1.932 \times 10^{1}$ $= 1.9 \times 10^{1}$ with significant figures
e. $(4.3 \times 10^{6})(6.1 \times 10^{5})$ $= 2.623 \times 10^{12}$ $= 2.6 \times 10^{12}$ with significant figures

1.55
a. $(6.3 \times 10^{5})(4.2 \times 10^{-8})$ $= 2.646 \times 10^{-2}$ $= 2.6 \times 10^{-2}$ with significant figures
b. $(2.8 \times 10^{-3})(1.4 \times 10^{-4})$ $= 3.92 \times 10^{-7}$ $= 3.9 \times 10^{-7}$ with significant figures
c. $(8.6 \times 10^{2})(6.4 \times 10^{-3})$ $= 5.504 \times 10^{0}$ $= 5.5 \times 10^{0}$ with significant figures
d. $(9.1 \times 10^{4})(1.4 \times 10^{3})$ $= 1.274 \times 10^{3}$ $= 1.3 \times 10^{8}$ with significant figures
e. $(3.7 \times 10^{5})(6.1 \times 10^{-3})$ $= 2.257 \times 10^{3}$ $= 2.3 \times 10^{3}$ with significant figures

1.56
a. (144)(0.0876) $= (1.44 \times 10^{2})(8.76 \times 10^{-2})$ $= 1.26144 \times 10^{1}$ $= 1.26 \times 10^{1}$ with SF
b. (751)(106) $= (7.51 \times 10^{2})(1.06 \times 10^{2})$ $= 7.9606 \times 10^{4}$ $= 7.96 \times 10^{4}$ with SF
c. (0.0422)(0.00119) $= (4.22 \times 10^{-2})(1.19 \times 10^{-3})$ $= 5.0218 \times 10^{-5}$ $= 5.02 \times 10^{-5}$ with SF
d. (128,000)(0.0000316) $= (1.28 \times 10^{5})(3.16 \times 10^{-5})$ $= 4.0448 \times 10^{0}$ $= 4.04 \times 10^{0}$ with SF

1.57
a. (538)(0.154) $= (5.38 \times 10^{2})(1.54 \times 10^{-1})$ $= 8.2852 \times 10^{1}$ $= 8.29 \times 10^{1}$ with SF
b. (600)(524) $= (6 \times 10^{2})(5.24 \times 10^{2})$ $= 3.144 \times 10^{5}$ $= 3 \times 10^{5}$ with SF
c. (22.8)(341) $= (2.28 \times 10^{1})(3.41 \times 10^{2})$ $= 7.7748 \times 10^{3}$ $= 7.77 \times 10^{3}$ with SF
d. (23.6)(0.047) $= (2.36 \times 10^{1})(4.7 \times 10^{-2})$ $= 1.1092 \times 10^{0}$ $= 1.1 \times 10^{0}$ with SF

1.58
a. $\frac{3.1\times10^{-3}}{1.2\times10^{2}}$ $= 2.583 \times 10^{-5}$ $= 2.6 \times 10^{-5}$ with SF
b. $\frac{7.9\times10^{4}}{3.6\times10^{2}}$ $= 2.194 \times 10^{2}$ $= 2.2 \times 10^{2}$ with SF
c. $\frac{4.7\times10^{-1}}{7.4\times10^{2}}$ $= 6.35135 \times 10^{-4}$ $= 6.4 \times 10^{-4}$ with SF
d. $\frac{0.00229}{3.16}$ $= 7.2468354 \times 10^{-4}$ $= 7.25 \times 10^{-4}$ with SF
e. $\frac{119}{3.8\times10^{3}}$ $= 3.131578947 \times 10^{-2}$ $= 3.1 \times 10^{-2}$ with SF

1.59
a. $\frac{233}{1.67}$ $= 1.33532934132 \times 10^{2}$ $= 1.34 \times 10^{2}$ with SF
b. $\frac{6.7\times10^{3}}{4.2\times10^{4}}$ $= 1.59523809524 \times 10^{-1}$ $= 1.6 \times 10^{-1}$ with SF
c. $\frac{8.7\times10^{-4}}{2.3\times10^{-2}}$ $= 3.78260869565 \times 10^{-2}$ $= 3.8 \times 10^{-2}$ with SF
d. $\frac{6.8\times10^{3}}{2.7\times10^{-4}}$ $= 2.5185185 \times 10^{7}$ $= 2.5 \times 10^{7}$ with SF

e. $\dfrac{1.8\times10^{-2}}{6.5\times10^{4}}$ = $2.7692307692 \times 10^{-7}$ = 2.8×10^{-7} with SF

☑1.60 a. $\dfrac{(5.3)(0.22)}{(6.1)(1.1)}$ = 1.7377×10^{-1} = 1.7×10^{-1} with SF

b. $\dfrac{(3.8\times10^{-4})(1.7\times10^{-2})}{6.3\times10^{3}}$ = 1.025×10^{-9} = 1.0×10^{-9} with SF

c. $\dfrac{4.8\times10^{6}}{(7.4\times10^{3})(2.5\times10^{-4})}$ = 2.59459×10^{6} = 2.6×10^{6} with SF

d. $\dfrac{5.6}{(0.022)(109)}$ = 2.335279×10^{0} = 2.3×10^{0} with SF

e. $\dfrac{(4.6\times10^{-3})(2.3\times10^{2})}{(7.4\times10^{-4})(9.4\times10^{-5})}$ = 1.520989×10^{7} = 1.5×10^{7} with SF

1.61 a. $\dfrac{(7.4\times10^{-3})(1.3\times10^{4})}{(5.5\times10^{-2})}$ = 1.749×10^{3} 1.7×10^{3} with SF

b. $\dfrac{6.4\times10^{5}}{(8.8\times10^{3})(1.9\times10^{-4})}$ = 3.82775×10^{3} = 3.8×10^{5} with SF

c. $\dfrac{(6.4\times10^{-2})(1.1\times10^{-8})}{(2.7\times10^{-4})(3.4\times10^{-4})}$ = 7.668845×10^{-3} = 7.7×10^{-3} with SF

d. $\dfrac{(963)(1.03)}{(0.555)(412)}$ = 4.3378×10^{0} = 4.34×10^{0} with SF

e. $\dfrac{1.15}{(0.12)(0.73)}$ = 1.312785×10^{1} = 1.3×10^{1} with SF

SIGNIFICANT FIGURES (SECTION 1.8)

1.62	a.	A ruler with smallest scale marking of 0.1 cm	0.01 cm
	b.	A measuring telescope with smallest scale marking of 0.1 mm	0.01 mm
	c.	A protractor with smallest scale marking of 1°	0.1°
	d.	A tire pressure with smallest scale marking of 1 lb/in^2	0.1 lb/in^2
1.63	a.	A buret with a smallest scale marking of 0.1 mL	0.01 mL
	b.	A graduated cylinder with a smallest scale marking of 1 mL	0.1 mL
	c.	A thermometer with a smallest scale marking of 0.1°C	0.01°C
	d.	A barometer with a smallest scale marking of 1 torr	0.1 torr
☑1.64	a.	Exactly 6 mL of water measured with a graduated cylinder that has smallest markings of 0.1 mL.	6.00 mL
	b.	A temperature that appears to be exactly 37 degrees using a thermometer with smallest markings of 1°C.	37.0°C
	c.	A time of exactly nine seconds measured with a stopwatch that has smallest markings of 0.1 second.	9.00 seconds

	d.	Fifteen and one-half degrees measured with a protractor that has 1 degree scale markings.	15.5°
1.65	a.	A length of two and one-half centimeters measured with a measuring telescope with a smallest scale marking of 0.1 mm.	2.500 cm
	b.	An initial reading of exactly 0 for a buret with a smallest scale marking of 0.1 mL.	0.00 mL
	c.	A length of four and one-half centimeters measured with a ruler that has a smallest scale marking of 0.1 cm.	4.50 cm
	d.	An atmospheric pressure of exactly 690 torr measured with a barometer that has a smallest scale marking of 1 torr.	690.0 torr

☑1.66 a. Measured = 5.06 lbs.
Exact = 16 potatoes

$$\frac{5.06\,\text{lb.}}{16\,\text{potatoes}} = 0.31625\frac{\text{lb.}}{\text{potato}} = 0.316\frac{\text{lb.}}{\text{potato}}\ \text{with SF}$$

b. Measured = percentages
Exact = 5 players

$$\frac{71.2\% + 66.9\% + 74.1\% + 80.9\% + 63.6\%}{5\,\text{players}} = 71.34\%\ \text{with SF}$$

1.67 a. Measured = 1 pm, 2 pm
Exact = 19, 24, 17, 31, 40 people

$$\frac{19 + 24 + 17 + 31 + 40\,\text{people}}{5\ \text{days}} = 26.2\frac{\text{people}}{\text{day}}$$

b. Measured = heights
Exact = 5 players

$$\frac{6'9" + 5'8" + 5'6" + 5'1" + 4'11"}{5\,\text{players}} = 5'7"\ \text{with SF}$$

1.68	a.	0.0400	3 SF (0.0<u>400</u>)	d.	4.4×10^{-3}	2 SF
	b.	309	3 SF	e.	1.002	4 SF
	c.	4.006	4 SF	f.	255.02	5 SF
1.69	a.	0.040	2 SF	d.	149.1	4 SF
	b.	11.91	4 SF	e.	10.003	5 SF
	c.	2.48×10^2	3 SF	f.	148.67	5 SF

1.70	a.	$(3.71)(1.4)$	5.194	= 5.2 with significant figures
	b.	$(0.0851)(1.2262)$	0.10434962	= 0.104 with significant figures
	c.	$\frac{(0.1432)(2.81)}{(0.7762)}$	0.518412780211	= 0.518 with significant figures
	d.	$(3.3\times10^{4})(3.09\times10^{-3})$	101.97	= 1.0×10^2 with significant figures
	e.	$\frac{(760.)(2.00)}{6.02\times10^{20}}$	$2.52491694352 \times 10^{-18}$	= 2.52×10^{-18} with significant figures (assuming 0 in 760 is significant)
1.71	a.	$(1.21)(3.2)$	3.872	= 3.9 with significant figures
	b.	$(6.02\times10^{23})(0.220)$	1.3244×10^{23}	= 1.32×10^{23} with significant figures
	c.	$\frac{(0.023)(1.1\times10^{-3})}{100}$	2.53×10^{-7}	= 3×10^{-7} with significant figures
	d.	$\frac{(365)(7.000)}{60}$	42.583333	= 4×10^1 with significant figures

	e.	$\dfrac{(810)(3.1)}{8.632\times10^{-1}}$	2908.94347	= 2.9×10^3 with significant figures
1.72	a.	$0.208+4.9+1.11$	= 6.218	= 6.2 with significant figures
	b.	$228+0.999+1.02$	= 230.019	= 2.30×10^2 with significant figures
	c.	$8.543-7.954$	= 0.589	= 0.589 with significant figures
	d.	$(3.2\times10^{-2})+(5.5\times10^{-1})$ (Hint: Write in decimal form first, then add.)	= 0.582	= 0.58 with significant figures
	e.	$336.86-309.11$	= 27.75	= 27.75 with significant figures
	f.	$21.66-0.02387$	= 21.63613	= 21.64 with significant figures
1.73	a.	2.1 + 5.07 + 0.119	= 7.289	= 7.3 with significant figures
	b.	0.051 + 8.11 + 0.02	= 8.181	= 8.18 with significant figures
	c.	4.337 - 3.211	= 1.126	= 1.126 with significant figures
	d.	$(2.93 \times 10^{-1}) + (6.2 \times 10^{-2})$ (Hint: Write in decimal form first, then add.)	= 0.355	= 0.355 with significant figures
	e.	471.19 – 365.09	= 106.1	= 106.10 with significant figures
	f.	17.76 - 0.0479	= 17.7121	= 17.71 with significant figures
1.74	a.	$\dfrac{(0.0267+0.00119)(4.626)}{28.7794}$	= 0.004483037867	= 0.00448 with significant figures
	b.	$\dfrac{212.6-21.88}{86.37}$	= 2.20817413454	= 2.208 with significant figures
	c.	$\dfrac{27.99-18.07}{4.63-0.88}$	= 2.6453333	= 2.65 with significant figures
	d.	$\dfrac{18.87}{2.46}-\dfrac{18.07}{0.88}$ (HINT: Do divisions first, then subtract.)	= -12.8633592018	= -13 with significant figures
	e.	$\dfrac{(8.46-2.09)(0.51+0.22)}{(3.74+0.07)(0.16+0.2)}$	= 3.3902741324	= 3 with significant figures
	f.	$\dfrac{12.06-11.84}{0.271}$	= 0.811808118081	= 0.81 with significant figures
1.75	a.	$\dfrac{132.15-32.16}{87.55}$	= 1.14209023415	= 1.142 with significant figures
	b.	$\dfrac{(0.0844+0.1021)(7.174)}{19.1101}$	= 0.070012768117	= 0.07001 with significant figures
	c.	$\dfrac{(2.78-0.68)(0.42+0.4)}{(1.058+0.06)(0.22+0.2)}$	= 3.66726296959	= 4 with significant figures
	d.	$\dfrac{27.635-21.71}{4.97-0.36}$	= 1.2852494577	= 1.29 with significant figures
	e.	$\dfrac{12.47}{6.97}-\dfrac{203.4}{201.8}$ (HINT: Do divisions first, then subtract.)	= 0.781167484035	= 0.78 with significant figures

f. $\dfrac{19.37-18.49}{0.822} = 1.07055961071 = 1.1$ with significant figures

1.76 a. **Area** $(A = l \times w)$ **Perimeter** $(P = 2(l) + 2(w))$

Black $A = 12.00\text{ cm} \times 10.40\text{ cm} = 124.8\text{ cm}^2$ $P = 2(12.00\text{ cm}) + 2(10.40\text{ cm}) = 44.80\text{ cm}$

Red $A = 20.20\text{ cm} \times 2.42\text{ cm} = 48.884\text{ cm}^2 = 48.9\text{ cm}^2$ $P = 2(20.20\text{ cm}) + 2(2.42\text{ cm}) = 45.24\text{ cm}$

Green $A = 3.18\text{ cm} \times 2.55\text{ cm} = 8.109\text{ cm}^2 = 8.11\text{ cm}^2$ $P = 2(3.18\text{ cm}) + 2(2.55\text{ cm}) = 11.46\text{ cm}$

Orange $A = 13.22\text{ cm} \times 0.68\text{ cm} = 8.9896\text{ cm}^2 = 9.0\text{ cm}^2$ $P = 2(13.22\text{ cm}) + 2(0.68\text{ cm}) = 27.80\text{ cm}$

b. **Length** **Width**

Black $12.00\ \cancel{\text{cm}}\left(\dfrac{1\text{ m}}{100\ \cancel{\text{cm}}}\right) = 0.1200\text{ m}$ $10.40\ \cancel{\text{cm}}\left(\dfrac{1\text{ m}}{100\ \cancel{\text{cm}}}\right) = 0.1040\text{ m}$

Red $20.20\ \cancel{\text{cm}}\left(\dfrac{1\text{ m}}{100\ \cancel{\text{cm}}}\right) = 0.2020\text{ m}$ $2.42\ \cancel{\text{cm}}\left(\dfrac{1\text{ m}}{100\ \cancel{\text{cm}}}\right) = 0.0242\text{ m}$

Green $3.18\ \cancel{\text{cm}}\left(\dfrac{1\text{ m}}{100\ \cancel{\text{cm}}}\right) = 0.0318\text{ m}$ $2.55\ \cancel{\text{cm}}\left(\dfrac{1\text{ m}}{100\ \cancel{\text{cm}}}\right) = 0.0255\text{ m}$

Orange $13.22\ \cancel{\text{cm}}\left(\dfrac{1\text{ m}}{100\ \cancel{\text{cm}}}\right) = 0.1322\text{ m}$ $0.68\ \cancel{\text{cm}}\left(\dfrac{1\text{ m}}{100\ \cancel{\text{cm}}}\right) = 0.0068\text{ m}$

Area $(A = l \times w)$ **Perimeter** $(P = 2(l) + 2(w))$

Black $A = 0.1200\text{ m} \times 0.1040\text{ m} = 0.01248\text{ m}^2$ $P = 2(0.1200\text{ m}) + 2(0.1040\text{ m}) = 0.4480\text{ m}$

Red $A = 0.2020\text{ m} \times 0.0242\text{ m} = 0.0048884\text{ m}^2 = 0.00489\text{ m}^2$ $P = 2(0.2020\text{ m}) + 2(0.0242\text{ m}) = 0.4524\text{ m}$

Green $A = 0.0318\text{ m} \times 0.0255\text{ m} = 8.109 \times 10^{-4}\text{ m}^2 = 8.11 \times 10^{-4}\text{ m}^2$ $P = 2(0.0318\text{ m}) + 2(0.0255\text{ m}) = 0.1146\text{ m}$

Orange $A = 0.1322\text{ m} \times 0.0068\text{ m} = 8.9896 \times 10^{-4}\text{ m}^2 = 9.0 \times 10^{-4}\text{ m}^2$ $P = 2(0.1322\text{ m}) + 2(0.0068\text{ m}) = 0.2780\text{ m}$

c. No, the number of significant figures in the answers remains constant. The numbers of places past the decimal are different; however, that could be fixed by rewriting all of the answers in scientific notation.

USING UNITS IN CALCULATIONS (SECTION 1.9)

1.77 a. 3.4 lb to kilograms $\dfrac{1\text{ kg}}{2.20\text{ lbs.}}$

b. 3.0 yd to meters $\dfrac{1\text{ m}}{1.094\text{ yd}}$

c. 1.5 oz to grams $\dfrac{1\text{ g}}{0.035\text{ oz}}$

d. 40 cm to inches $\dfrac{0.394\text{ in.}}{1\text{ cm}}$

1.78 a. 20. mg to grains $\dfrac{0.015\text{ grains}}{1\text{ mg}}$

b. 350 mL to fl oz $\dfrac{0.0338\text{ fl oz}}{1\text{ mL}}$

c. 4 qt to liters $\dfrac{1\text{ L}}{1.057\text{ qt}}$

d. 5 yd to meters $\dfrac{1\text{ m}}{1.094\text{ yd}}$

1.79 $$1.00\ \cancel{\text{gal}}\left(\frac{4\ \cancel{\text{qt}}}{1\ \cancel{\text{gallon}}}\right)\left(\frac{1\ \text{L}}{1.057\ \cancel{\text{qt}}}\right)=3.78429517502\ \text{L}=3.78\ \text{L}$$

1.80 $$26\ \cancel{\text{miles}}\left(\frac{1\ \text{km}}{0.621\ \cancel{\text{miles}}}\right)=41.8679549114\ \text{km}=42\ \text{km}$$

1.81 $$°\text{F}=\tfrac{9}{5}(200°\text{C})+32=392°\text{F}$$

☑1.82 $$250\ \cancel{\text{mL}}\left(\frac{0.0338\ \cancel{\text{fl oz}}}{1\ \cancel{\text{mL}}}\right)\left(\frac{1\ \text{cup}}{8\ \cancel{\text{fl oz}}}\right)=1.05625\ \text{cups}=1.1\ \text{cups}$$

(Note: Cups are not measured in 0.1 increments.)

1.83 $$62.75\ \cancel{\text{m}}\left(\frac{1.094\ \cancel{\text{yd}}}{1\ \cancel{\text{m}}}\right)\left(\frac{3\ \text{ft}}{1\ \cancel{\text{yd}}}\right)=205.9\ \text{ft}$$

1.84 $$18.0\ \cancel{\text{kg}}\left(\frac{2.20\ \text{lbs.}}{1\ \cancel{\text{kg}}}\right)=39.6\ \text{lbs}$$ The bag is not overweight.

1.85 $$3.00\ \cancel{\text{lbs.}}\left(\frac{\$3.41}{1\ \cancel{\text{lb.}}}\right)=\$10.23$$

1.86 $$131\frac{\cancel{\text{mg}}}{\cancel{\text{dL}}}\left(\frac{1\ \text{g}}{1000\ \cancel{\text{mg}}}\right)\left(\frac{10\ \cancel{\text{dL}}}{1\ \text{L}}\right)=1.31\frac{\text{g}}{\text{L}}$$

CALCULATING PERCENTAGES (SECTION 1.10)

1.87 $$\frac{55\ \text{years}}{65\ \text{years}}\ \text{x}\ 100=85\%$$

1.88 $$\frac{\$25.73}{\$467.80}\times 100=5.500\%$$

1.89 $$\frac{140\ \text{lbs}-32\ \text{lbs}}{140\ \text{lbs}}\ \text{x}\ 100=77\ \%$$

1.90 $$\frac{1.0\ \frac{\text{mg}}{\text{day}}}{1.4\ \frac{\text{mg}}{\text{day}}}\times 100=71\%$$

1.91 $$2000.\ \cancel{\text{Calories}}\left(\frac{45\ \text{Calories}}{100.\ \cancel{\text{Calories}}}\right)=900\ \text{Calories}=9.0\times 10^2\ \text{Calories with significant figures}$$

☑1.92 $$\text{Total}=987.1\ \text{mg}+213.3\ \text{mg}+99.7\ \text{mg}+14.4\ \text{mg}+0.1\ \text{mg}=1314.6\ \text{mg}$$

$IgG = \frac{987.1 \text{ mg}}{1314.6 \text{ mg}} \times 100 = 75.09\%$; $IgA = \frac{213.3 \text{ mg}}{1314.6 \text{ mg}} \times 100 = 16.23\%$; $IgM = \frac{99.7 \text{ mg}}{1314.6 \text{ mg}} \times 100 = 7.58\%$;

$IgD = \frac{14.4 \text{ mg}}{1314.6 \text{ mg}} \times 100 = 1.10\%$; $IgE = \frac{0.1 \text{ mg}}{1314.6 \text{ mg}} \times 100 = 0.008\%$

DENSITY (SECTION 1.11)

1.93 a. $\frac{3400.\text{ g}}{250.\text{ mL}} = 13.6 \frac{\text{g}}{\text{mL}}$

b. $\frac{925 \text{ g}}{500 \text{ mL}} = 1.85 \frac{\text{g}}{\text{mL}}$

c. $\frac{7.15 \text{ g}}{5.00 \text{ L}} = 1.43 \frac{\text{g}}{\text{L}}$

d. $\frac{350 \text{ g}}{200.\text{ cm}^3} = 1.75 \frac{\text{g}}{\text{cm}^3}$

1.94 a. $\frac{39.6 \text{ g}}{50.0 \text{ mL}} = 0.792 \frac{\text{g}}{\text{mL}}$

b. $\frac{243 \text{ g}}{236 \text{ mL}} = 1.03 \frac{\text{g}}{\text{mL}}$

c. $\frac{39.54 \text{ g}}{20.0 \text{ L}} = 1.98 \frac{\text{g}}{\text{L}}$

d. $\frac{222.5 \text{ g}}{25.0 \text{ cm}^3} = 8.90 \frac{\text{g}}{\text{cm}^3}$

1.95 $\text{Volume} = (5.50 \text{ cm})(12.0 \text{ cm})(4.00 \text{ cm}) = 264 \text{ cm}^3$

$\text{Density} = \frac{\text{mass}}{\text{volume}} = \frac{929.5 \text{ g}}{264 \text{ cm}^3} = 3.52 \frac{\text{g}}{\text{cm}^3}$

1.96 $\text{Volume} = (3.98 \text{ cm})^3 = 63.0 \text{ cm}^3$

$\text{Density} = \frac{\text{mass}}{\text{volume}} = \frac{718.3 \text{ g}}{(3.98 \text{ cm})^3} = 11.4 \frac{\text{g}}{\text{cm}^3}$

1.97 a. $\text{Volume} = 29.9 \text{ mL} - 25.2 \text{ mL} = 4.7 \text{ mL}$

$\text{Density} = \frac{\text{mass}}{\text{volume}} = \frac{12.4 \text{ g}}{4.7 \text{ mL}} = 2.6 \frac{\text{g}}{\text{mL}}$

b. $\text{Volume} = 21.7 \text{ mL} - 16.3 \text{ mL} = 5.4 \text{ mL}$

$\text{Density} = \frac{\text{mass}}{\text{volume}} = \frac{61.0 \text{ g}}{5.4 \text{ mL}} = 11 \frac{\text{g}}{\text{mL}}$

c. $\text{Volume} = 26.1 \text{ mL} - 20.7 \text{ mL} = 5.4 \text{ mL}$

$\text{Density} = \frac{\text{mass}}{\text{volume}} = \frac{11.7 \text{ g}}{5.4 \text{ mL}} = 2.2 \frac{\text{g}}{\text{mL}}$

☑1.98 $280.\ \cancel{\text{g}} \left(\frac{1 \text{ mL}}{0.736\ \cancel{\text{g}}} \right) = 380.\text{ mL}$

1.99 $100.0\ \cancel{\text{mL}} \left(\frac{1.49 \text{ g}}{1\ \cancel{\text{mL}}} \right) = 149 \text{ g}$

ADDITIONAL EXERCISES

1.100 a. $4.5 \text{ km} \left(\frac{1000 \text{ m}}{1 \text{ km}} \right) \left(\frac{1000 \text{ mm}}{1 \text{ m}} \right) = 4.5 \times 10^6 \text{ mm}$

b. $6.0\times10^{6}\ \text{mg}\left(\dfrac{1\ \text{g}}{1000\ \text{mg}}\right)=6.0\times10^{3}\ \text{g}$

c. $9.86\times10^{15}\ \text{m}\left(\dfrac{1\ \text{km}}{1000\ \text{m}}\right)=9.86\times10^{12}\ \text{km}$

d. $1.91\times10^{-4}\ \text{kg}\left(\dfrac{1000\ \text{g}}{1\ \text{kg}}\right)\left(\dfrac{1000\ \text{mg}}{1\ \text{g}}\right)=1.91\times10^{2}\ \text{mg}$

e. $5.0\ \text{ng}\left(\dfrac{1\ \text{g}}{10^{9}\ \text{ng}}\right)\left(\dfrac{1000\ \text{mg}}{1\ \text{g}}\right)=5.0\times10^{-6}\ \text{mg}$

1.101

$$2.99\times10^{-23}\ \cancel{\text{g water}}\left(\frac{11.2\ \text{g total hydrogen}}{100.\ \cancel{\text{g water}}}\right)=3.3488\times10^{-24}\ \text{g total hydrogen}$$

$$3.3488\times10^{-24}\ \text{g total hydrogen}\left(\frac{1}{2}\right)=1.67\times10^{-24}\ \text{g hydrogen}$$

1.102

$$170\ \cancel{\text{lbs. body weight}}\left(\frac{14\ \cancel{\text{lbs. fat}}}{100\ \cancel{\text{lbs. body weight}}}\right)\left(\frac{4500\ \cancel{\text{kcal}}}{1\ \cancel{\text{lb. fat}}}\right)\left(\frac{1\ \text{day}}{2000\ \cancel{\text{kcal}}}\right)=53.55\ \text{days}$$

$= 54$ days with significant figures

1.103

$$1.00\ \cancel{\text{quart}}\left(\frac{1\ \cancel{\text{L}}}{1.057\ \cancel{\text{quart}}}\right)\left(\frac{1\ \cancel{\text{mL}}}{10^{-3}\ \cancel{\text{L}}}\right)\left(\frac{0.812\ \text{g}}{1\ \cancel{\text{mL}}}\right)=768\ \text{g}$$

1.104

$$175\ \cancel{\text{lbs.}}\left(\frac{1\ \cancel{\text{kg}}}{2.2\ \cancel{\text{lbs.}}}\right)\left(\frac{12\ \text{mg}}{1\ \cancel{\text{kg}}}\right)=954.54\ \text{mg}$$

$= 9.5\times10^{2}$ mg with significant figures

1.105

$$4.0°\text{C}:\quad 1.00\ \cancel{\text{g}}\left(\frac{1\ \text{mL}}{1.00\ \cancel{\text{g}}}\right)=1.00\ \text{mL}$$

$$60.0°\text{C}:\quad 1.00\ \cancel{\text{g}}\left(\frac{1\ \text{mL}}{0.98\ \cancel{\text{g}}}\right)=1.02\ \text{mL}$$

$$\frac{1.02\ \text{mL}-1.00\ \text{mL}}{1.00\ \text{mL}}\times100=2\%\ \text{increase in volume}$$

CHEMISTRY FOR THOUGHT

1.106 a. To separate wood sawdust and sand, I would add water. The sawdust will float, while the sand will sink. The top layer of water and sawdust can be poured off into a filter. The water will run through the filter leaving the sawdust on the filter. The sawdust can then be allowed to dry. The remainder of the water and sand can be poured off into a filter and the sand can be allowed to dry.

b. To separate sugar and sand, I would add water to dissolve the sugar. I would then filter the mixture to isolate the sand. I would evaporate the water to isolate the sugar.

c. To separate iron filings and sand, I would use a magnet. The iron filings will be attracted to the magnet, while the sand will not be attracted to the magnet.

d. To separate sand soaked with oil, I would pour the mixture through a filter. The oil will go through the filter and leave the sand behind on the filter.

1.107 A bathroom mirror becomes foggy when someone takes a hot shower because the steam from the shower condenses on the cold glass of the mirror. This is a physical change because the water molecules are changing phase of matter, but not composition.

1.108

$$44.5\ \cancel{\text{kg}}\left(\frac{2.2\ \text{lbs.}}{1\ \cancel{\text{kg}}}\right) = 97.9\ \text{lbs.}$$

$$44.5 \div 2.2 = 20.2$$

This student should have used the relationship 2.2 lbs. = 1 kg to multiply 44.5 kg by 2.2 lbs./kg to find a weight of 97.9 lbs. The mistake she made appears to be that she divided 44.5 kg by 2.2 rather than multiplying by it. Consequently, she found a weight of only 20.2 lbs. Since she knows 2.2 lbs. = 1 kg, she was expecting the pound value to be larger than the kilogram value and she determined she had made a calculation error.

1.109 A mercury thermometer cannot be used to measure a temperature that is -45°C. A thermometer filled with a liquid that has a freezing point below -45°C could be used to measure this temperature.

1.110 Hang gliding confirms that air is an example of matter because air occupies space and has mass. If air did not occupy space or have mass, the hang glider would fall to the ground rather than gliding through the air.

1.111

$$27\ \cancel{\text{guests}}\left(\frac{1\ \cancel{\text{serving}}}{1\ \cancel{\text{guest}}}\right)\left(\frac{1\ \text{cup}}{3\ \cancel{\text{servings}}}\right) = 9\ \text{cups}$$

Assuming each of the guests eats one serving of oatmeal, 9 cups of dry oatmeal should be prepared.

1.112

$$\text{density} = \frac{240.8\ \text{g}}{60.1\ \text{mL} - 32.6\ \text{mL}} = \frac{240.8\ \text{g}}{27.5\ \text{mL}} = 8.76\ \tfrac{\text{g}}{\text{mL}}$$

The density of the object is only 8.76 g/mL; therefore, it does not have the same density as silver and is not silver.

1.113 All matter is made up of atoms of the elements and therefore contains chemicals.

1.114 When two teaspoons of sugar are dissolved in a small glass of water, the volume of the resulting solution is not significantly larger than the original volume of the water because as they dissolve, the sugar molecules are separated from one another and surrounded by water molecules. The sugar molecules fit in between the water molecules and do not significantly increase the volume of the solution.

ALLIED HEALTH EXAM CONNECTION

1.115 The physical properties include (b) boiling point and (d) osmolarity because these properties can be observed without changing (or attempting to change) the chemical composition of the materials.

1.116 (b) Iron forms rust is a chemical process because the chemical composition of iron is changing.

1.117 Only (b) rice and beans is a mixture.

1.118 $^{o}C = \frac{5}{9}(^{o}F\text{-}32)$ $^{o}C = \frac{5}{9}(92^{o}F - 32) = 33^{o}C$
(b) 92°F is approximately 33°C

1.119 $°F = \frac{9}{5}(°C) + 32$ $°F = \frac{9}{5}(25°C) + 32 = 77°F$
(d) 25°C is approximately 77°F.

1.120 $°C = \frac{5}{9}(°F - 32)$ $°C = \frac{5}{9}(72°F - 32) = 22°C$
(d) 72°F is 22.2°C.

1.121 The freezing point of water is (d) 273 K.

1.122 All matter is made up of atoms of the elements and therefore contains chemicals.

1.123 A calorie is a form of (b) heat.

1.124 There are (d) 10 millimeters in one centimeter.

1.125
$$4.50\times10^{2}\ \cancel{\text{nm}}\left(\frac{10^{-9}\ \cancel{\text{m}}}{1\ \cancel{\text{nm}}}\right)\left(\frac{1\ \text{pm}}{10^{-12}\ \cancel{\text{m}}}\right) = 4.50\times10^{5}\ \text{pm}$$
4.50×10^{2} nm is (d) 4.50×10^{5} pm.

1.126 One millimeter contains (c) 1,000 μm.

1.127
$$4.50\times10^{2}\ \cancel{\text{nm}}\left(\frac{10^{-9}\ \text{m}}{1\ \cancel{\text{nm}}}\right) = 4.50\times10^{-7}\ \text{m}$$

4.50×10^{2} nm is (c) 4.50×10^{-7} m.

1.128 The quantity 6,185 meters can be rewritten as (a) 6.185×10^{3} meters.

1.129 (b) $1{,}000{,}000 = 10^{6}$

1.130 There are (b) 10^{3} meters in a kilometer.

1.131 (d) $0.0562 = 5.62 \times 10^{-2}$

1.132 (c) $(27+93)\times5.1558 = 618.696 = 619$ with significant figures

1.133 (c) $36\ \cancel{\text{calories}}\left(\dfrac{1\text{ g CHO}}{4\ \cancel{\text{calories}}}\right) = 9\text{ g CHO}$

1.134 (c) $\dfrac{12\times 16}{2\times 27+3\times 32+12\times 16}\times 100 = 56\%$

1.135 $10\%\text{ solution} = \dfrac{10\text{ g glucose}}{100\text{ mL solution}}\times 100$

A 10% glucose solution contains (d) 10 grams of glucose per 100 milliliters of solution.

1.136 $50\ \cancel{\text{g}}\left(\dfrac{1\text{ mL}}{19.3\ \cancel{\text{g}}}\right) = 2.6\text{ mL}$

$50\ \cancel{\text{g}}\left(\dfrac{1\text{ mL}}{7.9\ \cancel{\text{g}}}\right) = 6.3\text{ mL}$

(b) $V_{Au} < V_{Fe}$

EXAM QUESTIONS
MULTIPLE CHOICE

1. The mass of an object is:
   a. the force between the object and the earth.
   b. a measure of the amount of matter in the object.
   c. the amount of space the object occupies.
   d. depends on the location of the object on the earth.

   Answer: B

2. Any two objects are attracted to each other by:
   a. gravity.
   b. electrostatic forces.
   c. magnetism.
   d. more than one response is correct

   Answer: A

3. How is the weight of an object influenced when the gravitational force on the object is increased?
   a. the weight decreases
   b. the weight increases
   c. the weight is unchanged
   d. the weight equal to the mass

   Answer: B

4. The weight of an object is:
   a. a measure of the gravitational force pulling the object toward the earth.
   b. equal to the mass of the matter in the object.
   c. a measure of the space occupied by the object.
   d. the same at any location on the earth.

   Answer: A

5. The fact that gold does not corrode is a:
   a. physical property.
   c. real property.

b. personal property. d. chemical property.

Answer: D

6. Which of the following represents a physical change in matter?
   a. A substance solidifies at 443 K.
   b. A substance produces a gas when heated.
   c. A substance burns when heated.
   d. A substance changes color when exposed to air.

   Answer: A

7. The melting of ice to liquid water is correctly classified as:
   a. a chemical change.
   b. a physical change.
   c. both a chemical and a physical change.
   d. neither a chemical nor a physical change.

   Answer: B

8. Which of the following is a physical property of matter?
   a. it does not burn
   c. freezes at -10˚F
   b. produces a gas when placed in an acid
   d. the surface turns black in air

   Answer: C

9. Which of the following is a chemical property of matter?
   a. color b. density c. freezing point d. flammability

   Answer: D

10. As two clear liquid solutions are added together, a red solid forms. This change is most likely:
    a. physical.
    c. neither chemical nor physical.
    b. chemical.
    d. both chemical and physical.

    Answer: B

11. The limit of chemical subdivision of an element is the:
    a. atom. b. molecule. c. proton. d. compound.

    Answer: A

12. Which of the following substances are composed of heteroatomic molecules?
    a. an iron nail b. oxygen c. copper wire d. water

    Answer: D

13. A molecule represented by O-O-O must be classified as:
    a. homoatomic and polyatomic.
    c. heteroatomic and polyatomic.
    b. homoatomic and monoatomic.
    d. heteroatomic and monoatomic.

    Answer: A

14. Which of the following terms correctly applies to a molecule of CO_2?
    a. triatomic, heteroatomic
    c. triatomic, homoatomic
    b. polyatomic, diatomic
    d. diatomic, heteroatomic

    Answer: A

15. Table salt, NaCl is best classified as a(n):

a. compound.
b. element.
c. homogeneous mixture.
d. heterogeneous mixture.

Answer: A

16. The limit of physical subdivision of pure H_2O is:
a. the atom. b. the molecule. c. the element. d. a proton.

Answer: B

17. Homoatomic pure substances are known as:
a. protons. b. elements. c. compound. d. molecules.

Answer: B

18. After heating, a pure substance, A, is found to produce both B and C. What can be said about the substance A?
a. It is an element.
b. It is a compound.
c. It is either an element or compound.
d. It is impossible to predict.

Answer: B

19. Two pure substances A and B react to form a new pure substance C. From this, we may conclude that:
a. A and B are both elements.
b. C is a compound, A and B may or may not be elements.
c. C is an element, A and B are compounds.
d. A, B, and C are all compounds.

Answer: B

20. Which of the following is an example of a homogeneous mixture?
a. NaOH solution
b. Mortar (mixture of water, sand and cement)
c. Vinegar and oil salad dressing
d. more than one response is correct

Answer: A

21. Which of the following consists of a single chemical species?
a. solution
b. homogeneous mixture
c. heterogeneous mixture
d. compound

Answer: D

22. Early measurements of length were based on:
a. dimensions of astronomical bodies.
b. dimensions of the human body.
c. dimensions of bodies of water.
d. distances between cities.

Answer: B

23. The metric system is a measurement system that is:
a. the official system for all nations of the world.
b. only used by a few of the nations of the world.
c. commonly used by U.S. physical scientists.
d. used exclusively in chemical calculations.

Answer: C

24. The basic unit of length in the metric system is the:
    a. mil. b. millimeter. c. foot. d. meter.

    Answer: D

25. Which of the following is an SI unit?
    a. pound c. meter
    b. liter d. calorie

    Answer: C

26. The prefix centi- denotes what fraction of a basic unit?
    a. 1/10 b. 1/100 c. 1/1000 d. 1000

    Answer: B

27. Which of the following is a derived unit of the SI system?
    a. kilogram b. meter c. cubic centimeter d. mole

    Answer: C

28. Convert a temperature of 76˚F to a Celsius value.
    a. 10 b. 24 c. 44 d. 169

    Answer: B

29. Which of the following numbers is correctly expressed using scientific notation?
    a. 3489 b. 5.248×10^4 c. 45.78×10^6 d. $.0987 \times 10^3$

    Answer: B

30. Do the following calculation, and express the answer using correct scientific notation.
    $$(2.97 \times 10^2) \times (6.09 \times 10^{-7})$$
    a. 5.53×10^3 b. 1.81×10^{-4} c. 4.88×10^8 d. 2.05×10^{-9}

    Answer: B

31. Do the following calculation, and express the answer using correct scientific notation.
    $$(6.00 \times 10^{23}) \times (3.00) / (284)$$
    a. 6.34×10^{21} b. 1.58×10^{-22} c. 6.34×10^{-2} d. 15.8

    Answer: A

32. The number 0.00816 expressed correctly using scientific notation is:
    a. 8.16×10^2. b. 8.16×10^3. c. 8.16×10^{-2}. d. 8.16×10^{-3}.

    Answer: D

33. How many significant figures are justified in a measurement of a length that is between 9 and 10 centimeters if the measuring device (ruler) has smallest divisions of 0.1 cm?
    a. one b. two c. three d. four

    Answer: C

34. How many significant figures are used in expressing a measurement as 0.2503 L?
    a. two b. three c. four d. five

    Answer: C

35. Which number has the greatest number of significant digits?

a. 1.0035 b. 17.5000 c. 0.0000625 d. 6.022×10^{23}

Answer: B

36. Do the following calculation and express the answer using the correct number of significant figures.

$$(342) \times (0.0012) \div 100.0$$

a. 0.00410 b. 0.0041 c. 4.10×10^{-3} d. 0.004104

Answer: B

37. Do the following calculation. How many significant figures are justified for the answer?

$$6.02 + 5.119 + 0.04218$$

a. three b. four c. five d. seven

Answer: B

38. A furnace delivers 8.0×10^4 BTU per hour. How many kilocalories per hour is this? (hint: 1 cal = 0.00397 BTU)

a. 3.2×10^{-5} kcal b. 3.2×10^2 kcal c. 2.0×10^4 kcal d. 2.5×10^2 kcal

Answer: C

39. Which of the following set-ups will allow you to calculate the cost of fruit in dollars per gram, if the price is given as 0.79 dollars per pound?

a. $\frac{0.79 \text{ dollars}}{\text{lb}} \times \frac{2.20 \text{ lb}}{1000 \text{ g}}$

b. $\frac{0.79 \text{ dollars}}{\text{lb}} \times \frac{457 \text{ g}}{1 \text{ dollar}}$

c. $\frac{\text{lb.}}{0.79 \text{ dollars}} \times \frac{1 \text{ lb}}{457 \text{ g}}$

d. $\frac{\text{lb}}{0.79 \text{ dollars}} \times \frac{1 \text{ kg}}{2.20 \text{ lb}}$

Answer: A

40. An entry wound is found to be 0.36 inch in diameter. Which of the follow guns was likely to have been used?

a. 9 mm Beretta b. 12 mm Uzi c. 200 mm Howitzer d. 0.5 cm pellet gun

Answer: A

41. Suppose the speedometer in your car reads 55.0 mph. What is your speed in km/hr? (1 km = 0.621 mi.)

a. 34.1 b. 0.029 c. 88.6 d. 0.011

Answer: C

42. Knowing that 1 g = 0.035 oz and 16 ounces = 1 lb. calculate the number of grams in 10 pounds.

a. 35 b. 0.56 c. 1.8 d. 4.6×10^3

Answer: D

43. If a student completes 5 problems out of a total of 8 on a pop quiz. What percentage of the quiz was completed?

a. 0.625 b. 6.25 c. 16.0 d. 62.5

Answer: D

44. If 13% of a class cheats on an exam and there are 93 students in the class, how many students should you recommend be expelled (to the nearest whole student)?

a. 9 b. 10 c. 12 d. 15

Answer: C

45. A hiker began a hike with a pint canteen full of water. One pint equals 16 fluid ounces. At the end of the hike, 7.0 fluid ounces of water remained. What percent of the water was *used* during the hike?
a. 78 b. 44 c. 56 d. 13

Answer: C

46. Eighteen students in a class will get this question correct. If that represents 45% of the class, how large is the class?
a. 20. b. 40. c. 60. d. 100.

Answer: B

47. If urine has a density of 1.08 g/mL, what would be the mass of a 125 mL urine sample?
a. 135 g b. 0.00864 g c. 116 g d. 125 g

Answer: A

48. You are able to carry a maximum of 20. kg. What is the maximum volume of gold that you can carry? (Au has a density of 19.6 g/cm^3)
a. 392 cm^3 b. 1.0x10^3 cm^3 c. 0.98 cm^3 d. none of these

Answer: B

49. The fact that iron (Fe) corrodes when exposed to water and air is a:
a. physical property.
b. metal property.
c. chemical property.
d. real property.

Answer: C

50. Convert 30.0 ^{0}C to Fahrenheit.
a. 112 b. 86.0 c. 48.7 d. 34.4

Answer: B

51. How can the volume of an irregular unknown object be measured?
a. using a ruler to measure length, width, and depth
b. measuring the volume of water displaced by the object
c. obtaining the mass of the object
d. measure the radius and use $V=\pi r^2$

Answer: B

52. Do the following calculation and express the answer using the correct number of significant figures.

$$(1.21 \times 10^{-3} + 1.3 \times 10^{-3}) \times 6.453 \times 10^{2} =$$

a. 1.619
b. 2
c. 1.6
d. 1.62

Answer: C

53. If a sample of blood was found to have a density of 1.05 g/mL, what would be the mass of 1.000 liters of this material? Express your answer with the proper number of significant figures.
a. 1.05x10^{-3} grams
b. 1.05x10^3 grams
c. 1050. grams
d. 1.050 kilograms

Answer: B

TRUE/FALSE

1. The number twelve, representing a dozen, has two significant figures.

   Answer: T

2. The number 6730.0 contains five significant figures.

   Answer: T

3. If 3333 is divided by 5.0, the answer should have two significant figures.

   Answer: T

4. If 6526 is added to 15.0, the answer should have two significant figures.

   Answer: F

5. To convert feet to inches, you should multiply by the factor 12 in./ft.

   Answer: T

6. To convert micrograms to grams, you should multiply by 1,000,000 g/microgram.

   Answer: F

7. To convert microliters to liters, you should multiply by 1 liter/1,000,000 microliters.

   Answer: T

8. If a 50 gram sample of iron alloy contains 40 grams if iron, it contains 80% iron by weight.

   Answer: T

9. If 100 people in a town of 5,000 people own a certain color car, this represents 0.1% of the population.

   Answer: F

10. If a 200 gram sample of water is partially frozen forming 40 g of ice, than 80% of the original sample is still a liquid.

    Answer: T

11. The evaporation of water is a chemical change.

    Answer: F

12. A patient weights 220 lbs. A medication for this patient is supposed to be taken 3 mg per kg per day. The correct dose for this patient is 3000 mg per day.

    Answer: F

13. A particular medication is a heterogeneous mixture. Since heterogeneous mixtures are consistent throughout, this medication does not need to be shaken.

    Answer: F

14. A Celsius degree is the same size as a Kelvin degree.

    Answer: T

15. One advantage of the Kelvin system is that it is impossible to have temperatures below zero.

    Answer: T

16. If the first ingredient on the label of a cosmetic is "active ingredient", the cosmetic is also regulated as a drug.

Answer: T

17. Henna is a hair coloring that causes a permanent change in color until the hair grows out. Henna is regulated as both a drug and a cosmetic because the change is permanent.

Answer: F

18. A quart is a metric unit.

Answer: F

19. A square meter is a derived unit.

Answer: T

20. Over the counter (OTC) medicines are dangerous because they are not regulated.

Answer: F