TEST BANK

Chemistry:
An Atoms-Focused Approach

SECOND EDITION

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PREFACE

HOW DOES IT WORK?

The Test Bank author listed the learning objectives from each chapter believed to be the most important for students to learn. The author then developed questions designed to test students' knowledge of a particular learning objective. By asking students questions that vary in both type and level of difficulty, instructors can gather different types of evidence, which will allow them to more effectively assess how well students understand specific concepts.

SIX QUESTION TYPES:

1. Remembering questions—test declarative knowledge, including textbook definitions and relationships between two or more pieces of information. Can students recall or remember the information in the same form it was learned?
2. Understanding questions—pose problems in a context different from the one in which the material was learned, requiring students to draw from their declarative and/or procedural understanding of important concepts. Can students explain ideas or concepts?
3. Applying questions—ask students to draw from their prior experience and use critical-thinking skills to take part in qualitative reasoning about the real world. Can students use learned information in another task or situation?
4. Analyzing questions—test students' ability to break down information and see how different elements relate to each other and to the whole. Can students distinguish among the different parts?
5. Evaluating questions—ask students to assess information as a whole and frame their own argument. Can students justify a stand or decision?
6. Creating questions—pose questions or objectives that prompt students to put elements they have learned together into a coherent whole to generate new ideas. Can students create a new product or point of view based on data?

THREE DIFFICULTY LEVELS:

1. Easy questions—require a basic understanding of the concepts, definitions, and examples.
2. Moderate questions—direct students to use critical-thinking skills, to demonstrate an understanding of core concepts independent of specific textbook examples, and to connect concepts across chapters.
3. Difficult questions—ask students to synthesize textbook concepts with their own experience, making analytical inferences about biological topics and more.

Each question measures and explicitly links to a specific competency and is written with clear, concise, and grammatically correct language that suits the difficulty level of the specific competency being assessed. To ensure the validity of the questions, no extraneous, ambiguous, or confusing material is included, and no slang expressions are used. In developing the questions, every effort has been made to eliminate bias (e.g., race, gender, cultural, ethnic, regional, handicap, age) to require specific knowledge of material studied, not of general knowledge or experience. This ensures accessibility and validity.

KEY TO THE QUESTION META-DATA

Each question in the Test Bank is tagged with five pieces of information designed to help instructors create the most ideal mix of questions for a quiz or exam. These tags are:

ANS: This is the correct answer for each question. Or, in the case of some short-answer questions, a possible correct answer to the given question.

DIF: This is the difficulty assigned to the problem. Problems have been classified as Easy, Medium, or Difficult.

REF: This is the section in the textbook from which a question is drawn.

OBJ: This is the learning objective that the question is designed to test.

MSC: This is the knowledge type (see above) the question is designed to test.

Chapter 1: Matter and Energy—An Atomic Perspective

LEARNING OBJECTIVES

Describe what is meant by the term *scientific theory* and distinguish it from *natural philosophy*.

Distinguish between elements and compounds.

Describe the scientific method and define a law, a theory, and a hypothesis.

Describe the law of definite proportions.

Describe the law of constant composition.

Describe the law of multiple proportions.

Write chemical formulas from the ratios of the elements in a compound.

Describe and apply the COAST method.

Distinguish between pure substances and mixtures.

Define matter and mass.

Describe and give examples of extensive and intensive properties.

Describe and give examples of chemical and physical properties.

Use density in calculations.

Distinguish between molecules and ions.

Distinguish between physical and chemical changes.

Distinguish between homogeneous and heterogeneous mixtures.

Describe the methods that can be used to separate the components of a mixture: distillation, filtration, and chromatography.

Distinguish between the states of matter: solid, liquid, and gas.

Describe how temperature affects the properties of matter.

Describe the processes of sublimation, melting, vaporization, condensation, freezing, and deposition.

Define energy, work, and heat.

Distinguish between potential and kinetic energy.

State the law of conservation of energy.

Recognize and interpret the different ways of representing molecules (diatomic, molecular formula, structural formula, condensed structural formula, ball-and-stick, space-filling).

Describe ionic compounds and identify an empirical formula.

Describe SI and US measurements.

Distinguish between exact and uncertain values.

Distinguish between precision and accuracy.

Apply the rules for significant figures (weak-link principle).

Use the unit-factor method to convert measurements.

Distinguish between and convert Fahrenheit, Celsius, and Kelvin temperatures.

Describe the function of a control sample.

For a data set, calculate the mean, standard deviation, and confidence interval.

Use Grubb's test to determine if a data point is an outlier.

MULTIPLE CHOICE

1. Which step is NOT a part of the scientific method?
   a. Form a testable hypothesis.
   b. Make observations.
   c. Conduct reproducible experiments.
   d. Identify different factors that affect results.
   e. Stop experimentation once the desired results are achieved.

   ANS: E DIF: Easy REF: 1.1
   OBJ: Describe the scientific method and define a law, a theory, and a hypothesis.
   MSC: Remembering

2. For a hypothesis to be considered a valid scientific theory, it must ________
   a. summarize experimental data without trying to predict future results.
   b. be impossible to prove wrong by experiment.
   c. explain widely observed phenomena based on extensive testing.
   d. never be modified or expanded.
   e. be voted on by the scientific community and accepted by all.

   ANS: C DIF: Easy REF: 1.1
   OBJ: Describe the scientific method and define a law, a theory, and a hypothesis.
   MSC: Understanding

3. According to the law of definite proportions, ________
   a. atoms forming a given compound react in variable proportions depending on conditions.
   b. different samples of the same compound contain the same proportions of the same elements.
   c. all compounds containing the same types of atoms have identical properties.
   d. all compounds containing the same types of atoms have relative masses that are whole-number multiples.
   e. only one type of molecule can be produced when two elements combine.

   ANS: B DIF: Easy REF: 1.1
   OBJ: Describe the law of definite proportions. MSC: Understanding

4. The law of definite proportions states that ________
   a. compounds such as NO and NO_2 have identical chemical properties.
   b. compounds such as NO and NO_2 must have masses that are whole-number multiples of each other.
   c. nitrogen and oxygen can combine to form a variety of compounds, such as NO or NO_2.
   d. the elements forming a given compound always react in the same proportions.
   e. only one compound can be produced when two elements combine.

   ANS: D DIF: Easy REF: 1.1
   OBJ: Describe the law of definite proportions. MSC: Understanding

5. Which one of the following is a hypothesis?
   a. Energy is required to vaporize a liquid.
   b. The composition of a pure substance is fixed and definite.
   c. Hydrogen gas and oxygen gas can react to form water.
   d. A Car's battery must be dead because the car won't start.
   e. Matter is composed of atoms.

   ANS: D DIF: Moderate REF: 1.1
   OBJ: Describe the scientific method and define a law, a theory, and a hypothesis.
   MSC: Applying

6. Which of the following illustrates the law of multiple proportions?
   a. The mass ratio of O to N in NO_2 is twice that in NO.
   b. NO_2 always contains one nitrogen atom and two oxygen atoms.
   c. The mass of NO_2 is a small whole-number multiple of the mass of NO.
   d. NO and NO_2 have similar chemical and physical properties.
   e. NO_2 and N_2O_4 are the same compound.

   ANS: A DIF: Moderate REF: 1.1
   OBJ: Describe the law of multiple proportions. MSC: Understanding

7. Which of the following does NOT illustrate the law of multiple proportions?
   a. The N-to-O mass ratio in NO is 0.875, whereas that in N_2O is 1.75.
   b. C_2H_2 has a 12:1 C-to-H mass ratio, while C_2H_6 has a 4:1 C-to-H mass ratio.
   c. The ratio of O:C by mass in CO_2 is twice that of CO.
   d. If a sample of H_2O contains 16 g of oxygen, a sample of H_2O_2 with the same number of molecules would contain 32 g of oxygen.
   e. H_2S and H_2O contain the same mass of hydrogen.

   ANS: E DIF: Difficult REF: 1.1
   OBJ: Describe the law of multiple proportions. MSC: Applying

8. Which of the following statements is NOT true?
   a. The relative numbers of each type of atom in a given compound do not vary.
   b. A compound always contains the same mass percentages of its constituent elements.
   c. A large sample and a small sample of a given compound contain the same number of each type of atom.
   d. A large sample and a small sample of a given compound contain the same types of atoms combined in the same proportions.
   e. A large sample and a small sample of a compound share the same chemical formula.

   ANS: C DIF: Difficult REF: 1.1
   OBJ: Describe the law of constant composition. MSC: Analyzing

9. Which of the following statements is NOT true?
   a. Given that the chemical formula of methanol is CH_4O, the number of carbon atoms in a sample of methanol will be the same as the number of oxygen atoms.
   b. If a compound is 75% carbon and 25% hydrogen by mass, 12 g of the compound contains 9 g C and 3 g H.
   c. If a compound contains 76 g of chlorine and 12 g of carbon, it will always have a 6.33:1 mass ratio of Cl to C.
   d. A compound containing 17.1 g of phosphorus and 58.9 g of chlorine has the same identity as a compound containing 35.7 g P and 204.3 g Cl.
   e. A compound containing 106.6 g of copper and 13.4 g of oxygen has the same identity as a compound containing 159.9 g Cu and 20.1 g O.

   ANS: D DIF: Difficult REF: 1.1
   OBJ: Describe the law of constant composition. MSC: Evaluating

10. A pure substance ________
    a. must be composed of atoms of the same type.
    b. cannot be separated into simpler substances by physical means.
    c. must be a compound.
    d. has different chemical properties depending on its source.
    e. can have a composition that varies from sample to sample.

    ANS: B DIF: Easy REF: 1.3
    OBJ: Distinguish between pure substances and mixtures. MSC: Remembering

11. Which of the following is NOT a pure substance?
    a. sparkling water
    b. gold metal
    c. oxygen gas
    d. water vapor
    e. dry ice (solid CO_2)

    ANS: A DIF: Easy REF: 1.3
    OBJ: Distinguish between pure substances and mixtures. MSC: Understanding

12. Which of the following is a pure substance?
    a. seawater
    b. blood
    c. brass (an alloy of copper and zinc)
    d. table sugar(sucrose, $C_{12}H_{22}O_{11}$)
    e. beer

    ANS: D DIF: Easy REF: 1.3
    OBJ: Distinguish between pure substances and mixtures. MSC: Understanding

13. A molecule ________
    a. must contain at least two types of atoms.
    b. can be an element or a compound.
    c. cannot form a solid.
    d. cannot be broken into its constituent atoms by any means.
    e. can contain only one type of atom.

    ANS: B DIF: Easy REF: 1.3
    OBJ: Distinguish between elements and compounds. MSC: Remembering

14. A sample of a compound ________
   a. breaks into its constituent atoms during phase changes.
   b. is a homogeneous mixture.
   c. contains atoms that can be physically separated from each other.
   d. contains at least two types of atoms in a constant, fixed ratio.
   e. has a variable composition depending on its temperature.

   ANS: D DIF: Easy REF: 1.3
   OBJ: Distinguish between elements and compounds. MSC: Remembering

15. Which of the following is an element?
   a. $C_6H_{12}O_6$
   b. HNO_3
   c. NaCl
   d. CH_4
   e. O_3

   ANS: E DIF: Easy REF: 1.3
   OBJ: Distinguish between elements and compounds. MSC: Understanding

16. Which of the following is NOT an element?
   a. Cs
   b. Au
   c. CS_2
   d. Ar
   e. Co

   ANS: C DIF: Easy REF: 1.3
   OBJ: Distinguish between elements and compounds. MSC: Understanding

17. An element ________
   a. can be separated into its components by physical methods.
   b. has different chemical properties depending on its state.
   c. cannot be separated into simpler substances by chemical methods.
   d. can also be a compound.
   e. exists only as atoms, not as molecules.

   ANS: C DIF: Easy REF: 1.3
   OBJ: Distinguish between elements and compounds. MSC: Understanding

18. Table sugar (sucrose, $C_{12}H_{22}O_{11}$) dissolves in water. This process ________
   a. is a chemical change.
   b. is a physical change.
   c. produces a heterogeneous mixture.
   d. is a chemical property of sucrose.
   e. converts sucrose to carbon dioxide and water.

   ANS: B DIF: Easy REF: 1.3
   OBJ: Distinguish between physical and chemical changes. MSC: Understanding

19. Which of the following is a homogeneous mixture?
    a. an egg
    b. smoke
    c. beach sand
    d. dry ice (solid CO_2)
    e. a salt solution (NaCl dissolved in water)

    ANS: E DIF: Easy REF: 1.3
    OBJ: Distinguish between homogeneous and heterogeneous mixtures.
    MSC: Understanding

20. Which of the following is a heterogeneous mixture?
    a. concrete
    b. sweet tea
    c. black coffee
    d. mercury metal
    e. an intravenous (IV) solution

    ANS: A DIF: Easy REF: 1.3
    OBJ: Distinguish between homogeneous and heterogeneous mixtures.
    MSC: Understanding

21. Distillation may be used to separate components in a mixture based on ________
    a. solubilities.
    b. masses.
    c. volatilities.
    d. densities.
    e. colors.

    ANS: C DIF: Easy REF: 1.3
    OBJ: Describe the methods that can be used to separate the components of a mixture: distillation, filtration, and chromatography. MSC: Remembering

22. Which of the following is a chemical property of formaldehyde (CH_2O)?
    a. It is flammable.
    b. It has a density of 1.09 g/mL.
    c. It is colorless.
    d. It dissolves in water.
    e. It is a gas at room temperature.

    ANS: A DIF: Easy REF: 1.3
    OBJ: Describe and give examples of chemical and physical properties.
    MSC: Remembering

23. Which of the following is a chemical property of copper metal?
    a. It conducts heat.
    b. It reacts with nitric acid to produce copper(II) nitrate.
    c. It melts at 1085°C
    d. It conducts electricity.
    e. It has an orange color.

    ANS: B DIF: Easy REF: 1.3
    OBJ: Describe and give examples of chemical and physical properties.
    MSC: Remembering

24. Which of the following represents a physical property of water?
    a. It boils at 100°C.
    b. An electrical current decomposes water into hydrogen gas and oxygen gas.
    c. It reacts with iron metal and oxygen to form rust.
    d. It reacts with carbon monoxide to form carbon dioxide and hydrogen gas.
    e. It is used in photosynthesis.

    ANS: A DIF: Easy REF: 1.3
    OBJ: Describe and give examples of chemical and physical properties.
    MSC: Remembering

25. Which of the following represents a chemical property of iron?
    a. Its density is 7.84 g/cm^3.
    b. It is magnetic.
    c. It reacts with oxygen in moist air.
    d. Its melting point is 1538°C.
    e. It conducts electricity.

    ANS: C DIF: Easy REF: 1.3
    OBJ: Describe and give examples of chemical and physical properties.
    MSC: Remembering

26. Which of the following is a chemical property of acetone (C_3H_6O)?
    a. It readily evaporates at room temperature.
    b. It has a pungent, irritating odor.
    c. It can be ignited in oxygen.
    d. It boils at 56°C.
    e. It is miscible with water.

    ANS: C DIF: Easy REF: 1.3
    OBJ: Describe and give examples of chemical and physical properties.
    MSC: Remembering

27. Which of the following is a chemical property of platinum?
    a. It conducts heat and electricity.
    b. It can react with chlorine gas to form platinum(IV) chloride.
    c. The difference between its melting and boiling points is 2057°C.
    d. It is a gray-white metal.
    e. Sound travels through it at a speed of 2680 m/s.

    ANS: B DIF: Easy REF: 1.3
    OBJ: Describe and give examples of chemical and physical properties.
    MSC: Remembering

28. Extensive properties are ________
    a. dependent on the amount of substance present.
    b. identical for all substances.
    c. independent of a substance’s phase.
    d. the physical properties of a substance.
    e. dependent on the reactivity of the substance.

    ANS: A DIF: Easy REF: 1.3
    OBJ: Describe and give examples of extensive and intensive properties.
    MSC: Remembering

29. Which one of the following represents a physical change?
    a. Milk turns sour.
    b. Rust forms on iron nails.
    c. Sugar ferments to form ethanol.
    d. An egg begins to smell very bad.
    e. Sugar melts and forms a syrupy liquid.

    ANS: E DIF: Easy REF: 1.3
    OBJ: Distinguish between physical and chemical changes. MSC: Understanding

30. Which one of the following represents a chemical change?
    a. Mercury(II) oxide is heated up and forms mercury metal and oxygen gas.
    b. Rubbing alcohol evaporates.
    c. Iodine vapor deposits on a surface.
    d. Iron metal is separated from sand using a magnet.
    e. Rock salt is pulverized.

    ANS: A DIF: Easy REF: 1.3
    OBJ: Distinguish between physical and chemical changes. MSC: Understanding

31. Which one of the following is NOT an intensive physical property of a pure liquid?
    a. boiling point
    b. conductivity
    c. mass
    d. density
    e. color

    ANS: C DIF: Moderate REF: 1.3
    OBJ: Describe and give examples of extensive and intensive properties.
    MSC: Remembering

32. Which statement is true regarding ammonia, NH_3?
    a. It can also be correctly represented as N_2H_6.
    b. It cannot be decomposed into simpler substances by any means.
    c. Its decomposition produces three volumes of hydrogen for every one volume of nitrogen.
    d. It can be separated into nitrogen and hydrogen atoms using distillation.
    e. It is not a stable molecule and does not exist at room temperature.

    ANS: C DIF: Moderate REF: 1.3
    OBJ: Distinguish between elements and compounds. MSC: Understanding

33. When copper metal is dropped into nitric acid, a blue solution containing copper(II) ions is produced along with brown nitrogen monoxide gas. Which of the following is an example of a chemical property?
    a. copper’s red-orange appearance
    b. nitrogen monoxide’s irritating odor
    c. the blue color of aqueous copper(II) ions
    d. the viscosity of nitric acid at room temperature
    e. nitric acid’s ability to react with copper metal

    ANS: E DIF: Moderate REF: 1.3
    OBJ: Describe and give examples of chemical and physical properties.
    MSC: Analyzing

34. If you had equal masses of each of the following substances, which would occupy the greatest volume?

a. ice (d = 0.917 g/mL)
b. water (d = 0.997 g/mL)
c. beeswax (d = 0.960 g/mL)
d. cocoa butter (d = 0.910 g/mL)
e. aluminum (d = 2.70 g/mL)

ANS: D DIF: Moderate REF: 1.3 OBJ: Use density in calculations.
MSC: Analyzing

35. The densities of glycerol and of mercury are 1.26 g/mL and 13.5 g/mL, respectively. What volume of glycerol has the same mass as 25.0 mL of mercury?

a. 268 mL
b. 426 mL
c. 2.33 mL
d. 1.47 mL
e. 338 mL

ANS: A DIF: Moderate REF: 1.3 OBJ: Use density in calculations.
MSC: Applying

36. Based on values for the volume per gram of the given materials, which of the following would NOT float in water (density = 0.997 g/cm^3)?

Substance	**g/cm^3**
Balsa wood	0.120
Cork	0.240
Charcoal (from oak)	0.571
Human fat	0.943
Ethylene glycol	1.11

a. balsa wood
b. cork
c. charcoal
d. human fat
e. ethylene glycol

ANS: E DIF: Moderate REF: 1.3 OBJ: Use density in calculations.
MSC: Applying

37. Calcite has a chemical formula of $CaCO_3$, and 1.0 g occupies approximately 0.369 cm^3. Pyrite (FeS_2) is 1.8 times denser than calcite. What is the density of FeS_2?

a. 2.7 g/cm^3
b. 0.66 g/cm^3
c. 4.9 g/cm^3
d. 2.2 g/cm^3
e. 1.5 g/cm^3

ANS: C DIF: Moderate REF: 1.3 OBJ: Use density in calculations.
MSC: Applying

38. Which of the following can be separated by filtration?
    a. rust particles in water
    b. air dispersed in whipped cream
    c. alcohol dissolved in water
    d. salt dissolved in water
    e. nitrogen from air

    ANS: A DIF: Moderate REF: 1.3
    OBJ: Describe the methods that can be used to separate the components of a mixture: distillation, filtration, and chromatography. MSC: Understanding

39. Which process would be a practical and effective way to separate beta-carotene, an orange pigment, from hexane liquid?
    a. filtration
    b. chromatography
    c. combustion
    d. scanning tunneling microscopy
    e. sublimation

    ANS: B DIF: Moderate REF: 1.3
    OBJ: Describe the methods that can be used to separate the components of a mixture: distillation, filtration, and chromatography. MSC: Applying

40. Acetone and water mix to form a homogeneous solution. Acetone has a boiling point of 56°C. Which of the following would be a suitable method for separating acetone from water?
    a. filtration
    b. combustion
    c. distillation
    d. scanning tunneling microscopy
    e. sublimation

    ANS: C DIF: Moderate REF: 1.3
    OBJ: Describe the methods that can be used to separate the components of a mixture: distillation, filtration, and chromatography. MSC: Applying

41. Which of the following is an intensive property of chlorine?
    a. It has mass.
    b. It boils at −34°C.
    c. Chlorine gas expands to fill a balloon.
    d. The reaction of chlorine with hydrogen releases a given amount of energy.
    e. Chlorine gas in a container exerts a given pressure at a given temperature.

    ANS: B DIF: Moderate REF: 1.3
    OBJ: Describe and give examples of extensive and intensive properties.
    MSC: Analyzing

42. Which represents an extensive property of hydrogen?
    a. Hydrogen gas is odorless and colorless.
    b. A hydrogen gas molecule is composed of two hydrogen atoms.
    c. Hydrogen gas is flammable.
    d. Hydrogen releases a given amount of energy when it reacts with oxygen.
    e. Hydrogen gas under normal conditions is nonmetallic.

    ANS: D DIF: Moderate REF: 1.3
    OBJ: Describe and give examples of extensive and intensive properties.
    MSC: Analyzing

43. The densities of cork, lead, and water are 0.240 g/cm^3, 11.34 g/cm^3, and 0.997 g/cm^3 at 25°C, respectively. If 20.0 g of lead are placed inside an 85.0 cm^3 piece of cork, what is the overall density, and will it float on water?

a. 0.466 g/cm^3; Yes, it will float.
b. 0.235 g/cm^3; Yes, it will float.
c. 0.211 g/cm^3; Yes, it will float.
d. 4.25 g/cm^3; No, it will not float.
e. 2.15 g/cm^3; No, it will not float.

ANS: A DIF: Difficult REF: 1.3 OBJ: Use density in calculations.
MSC: Applying

44. Soft solder is a blended alloy of tin (7.31 g/cm^3) and lead (11.34 g/cm^3) that is used in plumbing and electronics. It is 63.5% tin by mass. What is the density of the alloy?

a. 9.87 g/cm^3
b. 8.27 g/cm^3
c. 7.83 g/cm^3
d. 8.79 g/cm^3
e. 9.33 g/cm^3

ANS: D DIF: Difficult REF: 1.3 OBJ: Use density in calculations.
MSC: Evaluating

45. Gold (19.3 g/cm^3) and copper (8.96 g/cm^3) can be blended to form an alloy called rose gold. Suppose a rose-gold bar has a mass of 117 g and a volume of 7.00 cm^3. Calculate the mass percentage of gold in the bar.

a. 46.4%
b. 53.6%
c. 38.7%
d. 75.0%
e. 86.6%

ANS: D DIF: Difficult REF: 1.3 OBJ: Use density in calculations.
MSC: Evaluating

46. Which statement correctly describes the properties of gaseous helium (He)?

a. The gas is not highly compressible even though the atoms do not occupy the entire volume of the container.
b. The gas is highly compressible because there is a lot of empty space between the atoms.
c. The atoms are moving rapidly about the container, giving the gas its definite shape.
d. The gas has a definite volume and shape because the atoms are not moving about the container.
e. A gas takes the shape of the container, but its total volume cannot change.

ANS: B DIF: Easy REF: 1.4
OBJ: Distinguish between the states of matter: solid, liquid, and gas.
MSC: Remembering

47. Solid carbon dioxide (CO_2) can undergo sublimation to form gaseous CO_2. Which of the following statements is true?
    a. In the solid phase, CO_2 molecules easily slip past each other, and there are areas of randomly ordered molecules.
    b. In the gas phase, CO_2 molecules are strongly attracted to each other.
    c. The motion of the CO_2 molecules in the solid phase is much more restricted than in the gas phase.
    d. CO_2 molecules in the solid phase are easily compressed to smaller volumes.
    e. The CO_2 molecules decompose to form carbon and oxygen when they enter the gas phase.

    ANS: C DIF: Easy REF: 1.4
    OBJ: Distinguish between the states of matter: solid, liquid, and gas.
    MSC: Understanding

48. Which statement describing the properties of the different phases of a sample of matter is true?
    a. The particles in both the gas and liquid phases are highly ordered and in close proximity to one another.
    b. The particles in the liquid phase are highly compressible because they can slip past one another.
    c. The particles in both the solid and liquid phases are free to assume any shape, and their nearest neighbors change over time.
    d. The solid phase is rigid, even though its constituent particles may vibrate a little depending on their temperature.
    e. Localized areas of order can form in the gas phase because the particles experience significant attractions to one another.

    ANS: D DIF: Easy REF: 1.4
    OBJ: Distinguish between the states of matter: solid, liquid, and gas.
    MSC: Remembering

49. Equal amounts of water undergo the following changes. Which of the following would involve the largest change in energy?
    a. Ice is melted to form liquid water at 0°C.
    b. Ice at −25°C is heated to 0°C.
    c. Water is heated from 25°C to 50°C.
    d. Steam at 100°C is cooled and condensed to form liquid water at 85°C.
    e. Water at 0°C is heated and vaporized to form steam at 120°C.

    ANS: E DIF: Moderate REF: 1.4
    OBJ: Describe how temperature affects the properties of matter.
    MSC: Analyzing

50. Equal amounts of a pure substance undergo the following changes. Which process would you predict releases the greatest amount of energy?
    a. deposition (gas $\rightarrow$ solid)
    b. vaporization (liquid $\rightarrow$ gas)
    c. freezing (liquid $\rightarrow$ solid)
    d. condensation (gas $\rightarrow$ liquid)
    e. melting (solid $\rightarrow$ liquid)

    ANS: A DIF: Moderate REF: 1.4
    OBJ: Describe the processes of sublimation, melting, vaporization, condensation, freezing, and deposition. MSC: Analyzing

51. Which of the following is an example of potential energy?
    a. water running down a hill
    b. chemical bonds in table sugar (sucrose)
    c. electrons flowing through a wire
    d. a crowd moving a barricade
    e. molecules moving randomly in a liquid

    ANS: B DIF: Easy REF: 1.5
    OBJ: Distinguish between potential and kinetic energy. MSC: Understanding

52. Equal amounts of water are present under the following conditions. In which case do the water molecules have the highest kinetic energy?
    a. as ice at −10°C
    b. as steam at 100°C
    c. in the liquid phase at 80°C
    d. in the gas phase at 150°C
    e. in the solid phase at 0°C

    ANS: D DIF: Easy REF: 1.5
    OBJ: Distinguish between potential and kinetic energy. MSC: Understanding

53. If the speed of an object triples, its kinetic energy ________
    a. increases by a factor of 3.
    b. increases by a factor of 9.
    c. decreases by a factor of 3.
    d. decreases by a factor of 9.
    e. is unaffected.

    ANS: B DIF: Easy REF: 1.5
    OBJ: Distinguish between potential and kinetic energy. MSC: Applying

54. Which of the following statements about energy, work, and heat is NOT true?
    a. Adding heat to a sample of matter increases the average kinetic energy of its constituent particles.
    b. Thermal energy is the portion of the energy of an object that increases as temperature increases.
    c. When an object does work, part of the energy it expends is destroyed as it converts to heat.
    d. The energy available from some chemical reactions can be used to do work and/or produce heat.
    e. Heat involves the transfer of energy from a hotter object to a cooler one.

    ANS: C DIF: Moderate REF: 1.5
    OBJ: Define energy, work, and heat. MSC: Analyzing

55. Consider electrons traveling through a copper (Cu) wire at a speed of 0.024 cm/s. What is true about the energy of their motion?
    a. It is primarily kinetic.
    b. It is primarily potential.
    c. It would be unaffected if the speed of the electrons increased.
    d. It is strongly affected by gravity.
    e. It cannot be used to do work.

    ANS: A DIF: Moderate REF: 1.5
    OBJ: Distinguish between potential and kinetic energy. MSC: Applying

56. Work is defined as the exertion of force through a distance. Which of the following is NOT an example of work?
    a. Molecules in the air push against the blades of a windmill.
    b. Blood is pumped through the circulatory system.
    c. Electrons flow against the resistance present in a copper wire.
    d. Thermal energy (heat) is transferred from a hot stove to the surrounding air.
    e. A student lifts a book off of the floor.

    ANS: D DIF: Moderate REF: 1.5
    OBJ: Distinguish between potential and kinetic energy. MSC: Analyzing

57. Which has the highest kinetic energy, assuming all follow the equation KE = ½ mu^2, where m is the mass and u is the velocity?
    a. a one-ton (910 kg) truck traveling at 65 miles per hour (29 m/s)
    b. an electron with a mass of 9.11×10^{-27} kg traveling at 2.97×10^8 m/s (99% of the speed of light)
    c. an oxygen molecule with a mass of 5.31×10^{-26} kg traveling at 394 m/s (roughly its speed at room temperature)
    d. Usain Bolt, who has a mass of approximately 94 kg, running at 10 m/s (22.4 miles per hour)
    e. an oil tanker with a mass of 3×10^7 kg traveling at 9 m/s (20 miles per hour)

    ANS: E DIF: Moderate REF: 1.5
    OBJ: Distinguish between potential and kinetic energy. MSC: Analyzing

58. At what velocity would a proton be traveling if it had the same kinetic energy as an electron traveling at 10.0% of the speed of light?
    KE = ½ mu^2, where m is the mass and u is the velocity; proton mass = 1.673×10^{-27} kg; electron mass = 9.109×10^{-31} kg; speed of light = 2.998×10^8 m/s.
    a. 4.89×10^{11} m/s
    b. 2.45×10^{11} m/s
    c. 4.95×10^5 m/s
    d. 7.00×10^5 m/s
    e. 3.50×10^5 m/s

    ANS: D DIF: Difficult REF: 1.5
    OBJ: Distinguish between potential and kinetic energy. MSC: Evaluating

59. The electrostatic potential energy (E_{el}) between a pair of charged particles is proportional to their charges, Q_1 and Q_2, and inversely proportional to the distance between the centers of the ions, d. Oppositely charged particles attract each other, while like particles repel. Which statement is true?

    $$E_{el} \propto \frac{Q_1 \times Q_2}{d}$$

    a. As the distance between particles with like charges increases, the potential energy decreases.
    b. If d is doubled and Q_1 is doubled, the potential energy doubles.
    c. As the distance between particles with opposite charges increases, the potential energy decreases.
    d. If the magnitude of the charges increases, the potential energy decreases.
    e. If both Q_1 and Q_2 have a value of −1, the potential energy is negative.

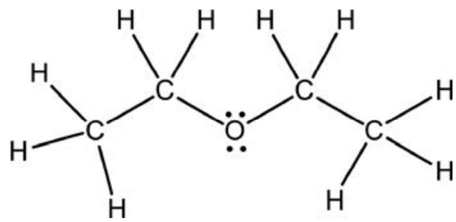
    ANS: A DIF: Difficult REF: 1.5
    OBJ: Distinguish between potential and kinetic energy. MSC: Evaluating

60. The chemical formula of dimethyl ether can be represented in different ways. When its formula is written as C_2H_6O, ________

a. the arrangement of the atoms in the molecule is evident.
b. only the number and type of atoms of each element are given.
c. its structural formula can be deduced.
d. it shows that no other molecules can have that formula.
e. it lists only one of many possible elemental compositions for dimethyl ether.

ANS: B DIF: Easy REF: 1.6
OBJ: Recognize and interpret the different ways of representing molecules (diatomic, molecular formula, structural formula, condensed structural formula, ball-and-stick, space-filling).
MSC: Remembering

61. What type of chemical formula is shown for diethyl ether?



a. molecular
b. structural
c. condensed structural
d. ball-and-stick
e. space-filling

ANS: B DIF: Easy REF: 1.6
OBJ: Recognize and interpret the different ways of representing molecules (diatomic, molecular formula, structural formula, condensed structural formula, ball-and-stick, space-filling).
MSC: Remembering

62. The space-filling model of a molecule ________

a. clearly shows bond angles.
b. gives little idea of how atoms are arranged.
c. is best suited for very large molecules.
d. gives an indication of three-dimensional shape.
e. spreads atoms out so they are easy to view.

ANS: D DIF: Easy REF: 1.6
OBJ: Recognize and interpret the different ways of representing molecules (diatomic, molecular formula, structural formula, condensed structural formula, ball-and-stick, space-filling).
MSC: Remembering

63. Ethanol and dimethyl ether molecules both contain two carbon atoms, six hydrogen atoms, and one oxygen atom. Which statement is true?
    a. Their molecular formulas are different.
    b. They show the same physical properties but different chemical properties.
    c. The arrangement of the atoms in each type of molecule is different.
    d. Their melting points and boiling points are the same.
    e. There is no physical method that can distinguish between the two.

    ANS: C DIF: Moderate REF: 1.6
    OBJ: Recognize and interpret the different ways of representing molecules (diatomic, molecular formula, structural formula, condensed structural formula, ball-and-stick, space-filling).
    MSC: Analyzing

64. Which of the following is the SI base unit for mass?
    a. g
    b. kg
    c. mg
    d. lb
    e. m

    ANS: B DIF: Easy REF: 1.7
    OBJ: Describe SI and US measurements. MSC: Remembering

65. Which of the following is not an SI base unit?
    a. °C
    b. s
    c. kg
    d. mol
    e. m

    ANS: A DIF: Easy REF: 1.7
    OBJ: Describe SI and US measurements. MSC: Remembering

66. Which of the following does not show a correct relationship between units?
    a. 1×10^3 g = 1 kg
    b. 1×10^{-3} s = 1 ms
    c. 1 nm = 1×10^{-9} m
    d. 1 GB = 1×10^9 B
    e. 1×10^{-6} μL = 1 L

    ANS: E DIF: Easy REF: 1.7
    OBJ: Describe SI and US measurements. MSC: Understanding

67. Which of the following does NOT show an exact relationship?
    a. 100 cm = 1 m
    b. 1 m^3 = 1000 L
    c. 1 in = 2.54 cm
    d. 1 km = 0.6214 mi
    e. 1 dozen = 12 objects

    ANS: D DIF: Easy REF: 1.7
    OBJ: Distinguish between exact and uncertain values. MSC: Remembering

68. Green light in the visible portion of the electromagnetic radiation spectrum has wavelengths around 550 nm. Express this wavelength in meters using exponential notation.
    a. 5.5×10^{-9} m
    b. 5.5×10^{-7} m
    c. 5.5 m
    d. 5.5×10^7 m
    e. 5.5×10^9 m

    ANS: B DIF: Easy REF: 1.7
    OBJ: Describe SI and US measurements. MSC: Understanding

69. The diameter of the sun is approximately 1,390,000 km. In correct scientific notation, this is ________

a. 1.39×10^{-6} km.
b. 1.39×10^{-9} m.
c. 1.39×10^{6} km.
d. 139×10^{4} km.
e. 1.39×10^{3} m.

ANS: C DIF: Easy REF: 1.7
OBJ: Describe SI and US measurements. MSC: Understanding

70. The atomic radius of a uranium atom is approximately 175 pm. In correct scientific notation, this is ________

a. 1.75×10^{-10} m.
b. 1.75×10^{-11} m.
c. 1.75×10^{-12} m.
d. 175×10^{-12} m.
e. 1.75×10^{10} m.

ANS: A DIF: Easy REF: 1.7
OBJ: Describe SI and US measurements. MSC: Understanding

71. The following measurements of the mass of an aspirin tablet were made by different students in a lab. Which set is the most precise?

a. 1.513 g, 1.503 g, 1.523 g
b. 1.513 g, 1.511 g, 1.450 g
c. 1.513 g, 1.459 g, 1.533 g
d. 1.513 g, 1.517 g, 1.512 g
e. 1.513 g, 1.505 g, 1.553 g

ANS: D DIF: Easy REF: 1.7
OBJ: Distinguish between precision and accuracy. MSC: Understanding

72. A student conducts repeated trials to determine the density of a sample of seawater and obtains the following results: 1.321 g/mL, 1.323 g/mL, 1.319 g/mL, and 1.321 g/mL. Known values are reported to be in the 1.02 to 1.09 g/mL range. The experimental results are ________

a. less precise than the known values.
b. more accurate than the known values.
c. imprecise but accurate.
d. precise and accurate.
e. inaccurate but precise.

ANS: E DIF: Easy REF: 1.7
OBJ: Distinguish between precision and accuracy. MSC: Understanding

73. If the following arithmetic operations were carried out, how many significant figures should the answer contain?

$0.750 \times 11 / 9.250$

a. 1
b. 2
c. 3
d. 4
e. 5

ANS: B DIF: Easy REF: 1.7
OBJ: Apply the rules for significant figures (weak-link principle).
MSC: Remembering

74. What value should be reported as the volume of a strip of aluminum foil measuring 15.37 cm × 42.5 cm × 0.0010 cm?

a. 0.65322 cm^3
b. 0.6532 cm^3
c. 0.653 cm^3
d. 0.65 cm^3
e. 0.7 cm^3

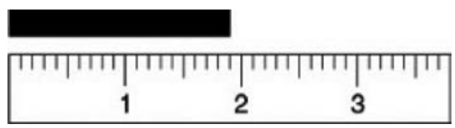
ANS: D DIF: Easy REF: 1.7
OBJ: Apply the rules for significant figures (weak-link principle).
MSC: Remembering

75. A metal object weighing 43.905 g has a volume of 6.0 cm^3. What is the density of the metal?

a. 7.3175 g/cm^3
b. 7.318 g/cm^3
c. 7.32 g/cm^3
d. 7.3 g/cm^3
e. 7 g/cm^3

ANS: D DIF: Easy REF: 1.7
OBJ: Apply the rules for significant figures (weak-link principle).
MSC: Understanding

76. Based on the following figure, which of the measurements listed is the best estimate of the length of the object?



a. 1.8 cm
b. 1.81 cm
c. 1.810 cm
d. 1.90 cm
e. 1.9 cm

ANS: D DIF: Easy REF: 1.7
OBJ: Apply significant figures to precision of measurement. MSC: Understanding

77. Which of the following common laboratory devices will deliver 25 mL of a solution with the greatest precision?

a. a 100 mL beaker without volume divisions
b. a 50 mL beaker with volume divisions every 10 mL
c. a 50 mL graduated cylinder with volume divisions every 2 mL
d. a 25 mL beaker without volume divisions
e. a 25 mL pipet with a to-deliver error of 0.01 mL

ANS: E DIF: Easy REF: 1.7
OBJ: Apply significant figures to precision of measurement. MSC: Understanding

78. White fuming nitric acid should contain no more than 2% water by mass. The water content in four samples was measured. What is the average value, and which measured value is closest to the average?

Sample	**% water, by mass**
1	1.983
2	1.927
3	1.946
4	1.956

a. 1.953, sample 4
b. 1.95, sample 4
c. 1.9530, sample 4
d. 1.9530, sample 3
e. 1.953, sample 3

ANS: A DIF: Easy REF: 1.7
OBJ: Apply significant figures to precision of measurement. MSC: Understanding

79. The average volume of a red blood cell is approximately 90 fL. Express the average value in liters using correct exponential notation and number of significiant figures.

a. 90×10^{-15} L
b. 9×10^{-15} L
c. 9.0×10^{-15} L
d. 9×10^{-14} L
e. 9.0×10^{-14} L

ANS: D DIF: Moderate REF: 1.7
OBJ: Describe SI and US measurements. MSC: Understanding

80. If the following arithmetic operations are carried out, how many significant figures should be reported in the answer?

$32 + 0.56 + 0.210 + 3.3$

a. 1
b. 2
c. 3
d. 4
e. 5

ANS: B DIF: Moderate REF: 1.7
OBJ: Apply the rules for significant figures (weak-link principle).
MSC: Applying

81. What value should be reported for the total mass of three samples of iron weighing 117.0 g, 19.43 g, and 6.1043 g?

a. 143 g
b. 142.53 g
c. 142.534 g
d. 142.5 g
e. 142.5343 g

ANS: D DIF: Moderate REF: 1.7
OBJ: Apply the rules for significant figures (weak-link principle).
MSC: Applying

82. If the following arithmetic operations are carried out, how many significant figures should be reported in the answer?

$$\frac{(0.600)(1.5366-0.708)}{2.105-1.83}+\frac{4.510}{0.752}$$

a. 1
b. 2
c. 3
d. 4
e. 5

ANS: B DIF: Moderate REF: 1.7
OBJ: Apply the rules for significant figures (weak-link principle).
MSC: Applying

83. A rectangular sheet of aluminum foil has a length of 8.0 cm, a width of 4.0 cm, and a mass of 864 mg. Determine the thickness of the foil, given that the density of aluminum is 2.70 g/cm^3.

a. 1.0 mm
b. 0.10 mm
c. 0.010 mm
d. 10. µm
e. 1.0×10^2 cm

ANS: B DIF: Moderate REF: 1.7
OBJ: Apply the rules for significant figures (weak-link principle).
MSC: Applying

84. A graduated cylinder is filled with water to the 25.0 mL mark. After 27.5 g of titanium dioxide (TiO_2) is added, the volume is 31.5 mL. Calculate the density of TiO_2.

a. 0.873 g/cm^3
b. 0.87 g/cm^3
c. 4.2 g/cm^3
d. 4.23 g/cm^3
e. 2.05 g/cm^3

ANS: C DIF: Moderate REF: 1.7
OBJ: Apply the rules for significant figures (weak-link principle).
MSC: Applying

85. Which of the following represents the largest mass?

a. 250 ng
b. 25 µg
c. 2.5 g
d. 0.25 kg
e. 25 mg

ANS: D DIF: Moderate REF: 1.7
OBJ: Describe SI and US measurements. MSC: Analyzing

86. Which of the following represents the smallest mass?

a. 4.0×10^0 mg
b. 4.0×10^2 ng
c. 4.0×10^{-4} g
d. 4.0×10^2 µg
e. 4.0×10^{-6} kg

ANS: B DIF: Moderate REF: 1.7
OBJ: Describe SI and US measurements. MSC: Analyzing

87. The distance between the two hydrogen atoms in a water molecule is about 1.355×10^{-10} m. This is equal to ________

a. 1.355×10^{-8} mm.
b. 1.355×10^{6} cm.
c. 1.355×10^{-6} µm.
d. 13.55 nm.
e. 135.5 pm.

ANS: E DIF: Moderate REF: 1.7
OBJ: Describe SI and US measurements. MSC: Analyzing

88. The calculated diameter of a carbon atom is about 0.000000000340 m. In correct scientific notation, this is equal to ________

a. 3.40×10^{-12} km.
b. 3.40×10^{-12} cm.
c. 3.40×10^{-8} mm.
d. 3.40×10^{0} nm.
e. 3.40×10^{2} pm.

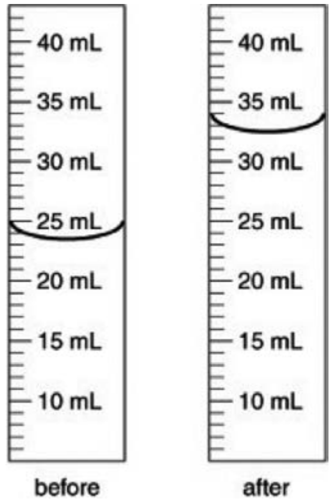
ANS: E DIF: Moderate REF: 1.7
OBJ: Describe SI and US measurements. MSC: Analyzing

89. The average diameter of a red blood cell is about 7×10^{-6} m. Choose the *best* way to represent this distance using SI units and prefixes.

a. 7 µm
b. 0.007 mm
c. 0.000007 m
d. 7000 nm
e. 7000000 pm

ANS: A DIF: Moderate REF: 1.7
OBJ: Describe SI and US measurements. MSC: Analyzing

90. An irregularly shaped metal object with a mass of 25.43 g was placed in a graduated cylinder with water. The before and after volumes are shown below. What is the density of the metal?



a. 2.826 g/cm^3
b. 2.8 g/cm^3
c. 0.35 g/cm^3
d. 0.3539 g/cm^3
e. 2.5 g/cm^3

ANS: B DIF: Moderate REF: 1.7
OBJ: Apply the rules for significant figures (weak-link principle).
MSC: Applying

91. An 84.6419 g antique coin is thought to be gold. When the coin is placed in a graduated cylinder containing 15.53 mL of water, the water level rises to 24.64 mL. Calculate the density of the coin.

a. 9.29 g/mL
b. 5.450 g/mL
c. 0.73833 g/mL
d. 9.2911 g/mL
e. 3.435 g/mL

ANS: A DIF: Moderate REF: 1.7
OBJ: Apply the rules for significant figures (weak-link principle).
MSC: Applying

92. A student performed three measurements to determine the density of water at 25°C to four significant figures. The known density of water at 25°C to three significant figures is 0.997 g/mL. The student obtained the following results.

Trial	Density (g/mL)
1	0.9345
2	0.9623
3	0.9007

The measurements were ________

a. sufficiently precise but not accurate.
b. sufficiently accurate but not precise.
c. both sufficiently precise and accurate.
d. neither sufficiently precise nor accurate.
e. not repeated an adequate number of times.

ANS: D DIF: Moderate REF: 1.7
OBJ: Apply significant figures to precision of measurement. MSC: Analyzing

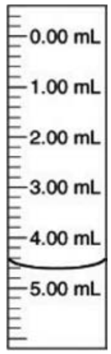
93. A particular brand of beer must maintain an alcohol content by volume of 5.65 to 5.75%. Analyses at four independent labs of an artificial beer sample with an alcohol content of 5.68% by volume yielded the following data. What can be deduced from these results?

Lab	Alcohol by volume (%)
1	5, 6
2	5.682, 5.678
3	5.7, 5.6
4	2.3365, 2.3375
Actual value from many measurements	5.6765

a. The values from lab 1 are both imprecise and inaccurate.
b. Lab 2 provides sufficiently precise and accurate values.
c. The values from lab 3 are sufficiently precise and accurate.
d. The data from lab 4 should be used based on its precision.
e. None of the data meet the brewer's specifications.

ANS: B DIF: Moderate REF: 1.7
OBJ: Apply significant figures to precision of measurement. MSC: Analyzing

94. A buret (shown below) was used to add dilute hydrochloric acid (HCl) to a sodium hydroxide solution. If the buret initially was read as 0.00 mL, how much HCl has been delivered according to the reading in the figure?



a. 5.4 mL
b. 5.40 mL
c. 4.60 mL
d. 4.6 mL
e. 4.30 mL

ANS: C DIF: Moderate REF: 1.7
OBJ: Apply significant figures to precision of measurement. MSC: Applying

95. A 50.0 mL graduated cylinder has a mass of 67.780 g. Metal pellets are added, and the total mass increases to 135.284 g. The cylinder is filled to the 25.0 mL mark with glycerol, which has a density of 1.261 g/cm^3. The combined mass of the graduated cylinder, metal pellets, and glycerol is 159.303 g. Calculate the density of the metal pellets.

a. 2.70 g/cm^3
b. 3.66 g/cm^3
c. 5.95 g/cm^3
d. 6.37 g/cm^3
e. 11.3 g/cm^3

ANS: E DIF: Difficult REF: 1.7
OBJ: Apply the rules for significant figures (weak-link principle).
MSC: Evaluating

96. A pycnometer is a device used to find the volume of an object based on mass and water displacement. Use the following information to find the volume of a brass cylinder that has a mass of 33.9633 g.

A pycnometer completely filled with water (0.997044 g/cm^3) has a mass of 94.43 g. When the brass cylinder is placed inside the pycnometer full of water, it displaces a volume of water equal to the volume of the cylinder. The total mass of the pycnometer, cylinder, and remaining water is 124.19 g.

a. 29.67 cm^3
b. 4.203 cm^3
c. 4.191 cm^3
d. 29.85 cm^3
e. 4.215 cm^3

ANS: E DIF: Difficult REF: 1.7
OBJ: Apply the rules for significant figures (weak-link principle).
MSC: Evaluating

97. Based on density, which of the following liquids is probably water?
1 L = 1.057 quarts (qt) = 0.2642 gallons (gal) = 33.814 fluid ounces (fl oz); 1 in = 2.54 cm;
1 pound (lb) = 16 ounces (oz) = 453.6 g.

a. 355 µL has a mass of 312 mg.
b. 8.00 fl oz has a mass of 260 g.
c. 1.0 gal has a mass of 3.4 kg.
d. 0.50000 qt weighs 1.0427 lb.
e. 1.00 in^3 weighs 0.454 oz.

ANS: D DIF: Difficult REF: 1.7 OBJ: Use density in calculations.
MSC: Analyzing

98. The deepest point in the Mariana Trench is approximately 10.9 km. What is this depth in feet?
(1 mi = 5280 ft = 1.609 km)

a. 57,600 ft
b. 35,800 ft
c. 10,900 ft
d. 17,500 ft
e. 8490 ft

ANS: B DIF: Easy REF: 1.8
OBJ: Use the unit-factor method to convert measurements. MSC: Understanding

99. Blood volume in an average adult is about 4.7 L. A 68 kg person should have a total cholesterol level of no more than the exact reference value of 200 mg cholesterol per deciliter of blood. How many grams of cholesterol are present in 4.7 L of blood at this level?

a. 94 g
b. 0.94 g
c. 9.4 g
d. 43 g
e. 4.3 g

ANS: C DIF: Easy REF: 1.8
OBJ: Use the unit-factor method to convert measurements. MSC: Understanding

100. On July 10, 1913, the world-record highest air temperature was recorded to be 134°F at Furnace Creek Ranch in Death Valley, California. What is this temperature in degrees Celsius?

a. 42°C
b. 74°C
c. 106°C
d. 57°C
e. 92°C

ANS: D DIF: Easy REF: 1.8
OBJ: Distinguish between and convert Fahrenheit, Celsius, and Kelvin temperatures.
MSC: Applying

101. Liquid oxygen boils at 90.19 K. What is this temperature in degrees Celsius?

a. −182.96°C
b. 90.19°C
c. 182.96°C
d. −90.19°C
e. −273.15°C

ANS: A DIF: Easy REF: 1.8
OBJ: Distinguish between and convert Fahrenheit, Celsius, and Kelvin temperatures.
MSC: Applying

102. The lowest recorded air temperature on Earth was recorded on July 21, 1983, to be –89.2°C at the Russian Vostok Station in Antarctica. What is this temperature in degrees Fahrenheit?

a. −128.6°F
b. −103.0°F
c. −17.6°F
d. −31.8°F
e. −218.2°F

ANS: A DIF: Easy REF: 1.8
OBJ: Distinguish between and convert Fahrenheit, Celsius, and Kelvin temperatures.
MSC: Applying

103. On average, the total body content of cholesterol in a 150 lb person may be around 35 grams. If the mass of one cholesterol molecule ($C_{27}H_{46}O$) is about 6.4×10^{-22} g, how many cholesterol molecules are present in this person?

a. 3.5×10^{-23} molecules
b. 1.8×10^{-23} molecules
c. 1.8×10^{22} molecules
d. 6.4×10^{22} molecules
e. 5.5×10^{22} molecules

ANS: E DIF: Easy REF: 1.8
OBJ: Use the unit-factor method to convert measurements. MSC: Understanding

104. The average velocity of an oxygen molecule at room temperature is about 480 m/s. Approximately how many miles would this oxygen molecule travel in one hour? (1 mi = 1609 m.)

a. 1,100,000 mi
b. 18,000 mi
c. 12,000 mi
d. 1100 mi
e. 18 mi

ANS: D DIF: Easy REF: 1.8
OBJ: Use the unit-factor method to convert measurements. MSC: Understanding

105. The brightest star in the constellation Ursa Minor (the Little Dipper) is Polaris, which is also known as the North Star because it is the closest to Earth's celestial North Pole. Assuming light travels 2.998×10^{8} m in one second, how long does it take light to travel the 3.27×10^{15} km distance from Sirius to Earth?

a. 7.57 days
b. 346 years
c. 5.02 years
d. 182 min
e. 4480 years

ANS: B DIF: Moderate REF: 1.8
OBJ: Use the unit-factor method to convert measurements. MSC: Applying

106. Which one of the following is NOT equal to exactly 1 cubic meter ($1\ m^3$)?

a. $10^6\ cm^3$
b. 10^3 L
c. $10^9\ mm^3$
d. 10^6 mL
e. $100\ cm^3$

ANS: E DIF: Moderate REF: 1.8
OBJ: Describe SI and US measurements. MSC: Applying

107. The period at the end of this sentence has an area of approximately 0.2 mm^2. One carbon atom, having a diameter of about 160 pm, covers an area of about 0.02 nm^2. How many carbon atoms would be required to produce a one-atom-deep layer that covers 0.2 mm^2?

a. 1×10^{12}
b. 2×10^{11}
c. 1×10^{7}
d. 1×10^{13}
e. 2×10^{6}

ANS: D DIF: Moderate REF: 1.8
OBJ: Use the unit-factor method to convert measurements. MSC: Applying

108. The gold foil used by Ernest Rutherford in his investigations of atomic structure was approximately 1 μm thick. Given that the radius of a gold atom is approximately 130 pm, how many atoms thick was the foil?

a. 4×10^{3}
b. 4×10^{6}
c. 4×10^{9}
d. 4×10^{10}
e. 4×10^{12}

ANS: A DIF: Moderate REF: 1.8
OBJ: Use the unit-factor method to convert measurements. MSC: Applying

109. If the diameter of a helium atom is about 0.064 nm, how many helium atoms lined up side to side would span the diameter of a human hair, which is about 0.1 mm?

a. 2×10^{-6}
b. 2×10^{12}
c. 2×10^{3}
d. 2×10^{6}
e. 2×10^{9}

ANS: D DIF: Moderate REF: 1.8
OBJ: Use the unit-factor method to convert measurements. MSC: Analyzing

110. The temperature of the sun's surface is approximately 5780 K. What is this temperature in degrees Fahrenheit?

a. 5510°F
b. 6260°F
c. 9940°F
d. 3030°F
e. 10,900°F

ANS: C DIF: Moderate REF: 1.8
OBJ: Distinguish between and convert Fahrenheit, Celsius, and Kelvin temperatures.
MSC: Applying

111. Carbon in the diamond form spontaneously begins burning in air at a temperature of about 1330°F. What is this temperature in K?

a. 495 K
b. 994 K
c. 955 K
d. 562 K
e. 1250 K

ANS: B DIF: Moderate REF: 1.8
OBJ: Distinguish between and convert Fahrenheit, Celsius, and Kelvin temperatures.
MSC: Applying

112. It takes about 18 seconds for the 4.7 L of blood present in the average adult to circulate through the entire body. Blood contains about 5×10^6 red blood cells (RBC) per microliter. On average, how many RBC circulate through the system per second?

a. 2×10^1 RBC
b. 3×10^6 RBC
c. 1×10^6 RBC
d. 5×10^6 RBC
e. 1×10^{12} RBC

ANS: E DIF: Difficult REF: 1.8
OBJ: Use the unit-factor method to convert measurements. MSC: Evaluating

113. Officials estimate that the eruptions of Mount St. Helens in 1980 released roughly 2.4 million cubic yards of ash having a mass of about 820 million kg. What was the approximate density of the ash? (1 yd = 0.9144 m.)

a. 0.045 g/cm^3
b. 0.45 g/cm^3
c. 0.045 g/cm^3
d. 2.2 g/cm^3
e. 0.22 g/cm^3

ANS: B DIF: Difficult REF: 1.8
OBJ: Use the unit-factor method to convert measurements. MSC: Evaluating

114. The density of quartz is 165 lb/ft^3. A clear crysta of unknown composition with a mass of 26.5 g is found to displace 10.0 cm^3 of water. The crystal has a density ________ (1 lb = 453.6 g; 1 m^3 = 1×10^6 cm^3 = 35.31 ft^3.)

a. of 165 lb/ft^3 and therefore could be quartz.
b. of 2.65 g/cm^3 and therefore cannot be quartz.
c. of 170 lb/ft^3 and might be quartz. Better measurements are needed for a definitive test.
d. of 4.24 g/cm^3. Better measurements are needed for a definitive test.
e. very different from that of quartz.

ANS: A DIF: Difficult REF: 1.8
OBJ: Use the unit-factor method to convert measurements. MSC: Evaluating

115. The densities of diamond and of cubic zirconia are 220 lb/ft^3 and 355 lb/ft^3, respectively. A clear crystal with a mass of 35.0 g is found to displace 6.17 cm^3 of water. The crystal has a density ________ (1 lb = 453.6 g; 1 m^3 = 1×10^6 cm^3 = 35.31 ft^3.)

a. of 3.52 g/cm^3 and might be diamond.
b. of 5.67 g/cm^3 and might be diamond.
c. of 354 lb/ft^3 and might be cubic zirconia.
d. of 135 lb/ft^3 and is not diamond or cubic zirconia.
e. that matches neither diamond nor cubic zirconia.

ANS: C DIF: Difficult REF: 1.8
OBJ: Use the unit-factor method to convert measurements. MSC: Evaluating

116. The mass of an atom is concentrated primarily in its nucleus. If the mass of a uranium atom's nucleus is about 4×10^{-21} g and its radius is about 8 fm, what is the approximate density of the nucleus? The volume of a sphere is $4\pi r^3/3$.

a. 2×10^{17} g/cm^3
b. 2×10^{9} g/cm^3
c. 2×10^{6} g/cm^3
d. 2×10^{12} g/cm^3
e. 2×10^{15} g/cm^3

ANS: E DIF: Difficult REF: 1.8
OBJ: Use the unit-factor method to convert measurements. MSC: Evaluating

117. The largest gold bar in the world (as of 2013) is 17.9 in × 8.86 in × 6.69 in. Assuming the bar is pure gold with a density of 19.3 g/cm^3, how many pounds does the bar weigh?
(1 in = 2.54 cm; 1 lb = 453.6 g.)

a. 336,000 lb
b. 316 lb
c. 1060 lb
d. 7.40×10^2 lb
e. 9.00×10^2 lb

ANS: D DIF: Difficult REF: 1.8
OBJ: Use the unit-factor method to convert measurements. MSC: Evaluating

118. A five-year-old child suffering a potentially fatal allergic reaction to peanuts needs an emergency injection of 0.12 mg of epinephrine from a bottle labeled 100 μg epinephrine per milliliter of solution. What volume of this solution should the child receive?

a. 0.12 mL
b. 120 mL
c. 1.2×10^{-4} mL
d. 12 mL
e. 1.2 mL

ANS: E DIF: Difficult REF: 1.8
OBJ: Use the unit-factor method to convert measurements. MSC: Evaluating

119. A patient is to receive 4.00 grams of a cephalosporin antibiotic by IV per day. The 0.500 L IV bag is labeled as containing 500.0 mg cephalosporin per 100.0 mL normal saline solution. What should the flow rate of the IV drip be in milliliters per minute?

a. 0.139 mL/min
b. 0.160 mL/min
c. 0.347 mL/min
d. 0.556 mL/min
e. 2.88 mL/min

ANS: D DIF: Difficult REF: 1.8
OBJ: Use the unit-factor method to convert measurements. MSC: Evaluating

120. The atomic radius of a gold atom is about 130 pm. Determine the maximum number of atoms that would create a 2×10^2 cm^3 sphere (roughly the size of a baseball). The volume of a sphere is $4\pi r^3/3$.

a. 2.1×10^{5}
b. 2×10^{25}
c. 2×10^{17}
d. 2.7×10^{24}
e. 2.1×10^{31}

ANS: B DIF: Difficult REF: 1.8
OBJ: Use the unit-factor method to convert measurements. MSC: Evaluating

121. At what temperature do the Celsius and Fahrenheit scales have the same value?
a. 40°
b. –40°
c. 11.4°
d. −11.4°
e. There is no temperature at which the two scales have the same value.

ANS: B DIF: Difficult REF: 1.8
OBJ: Distinguish between and convert Fahrenheit, Celsius, and Kelvin temperatures.
MSC: Evaluating

122. At what temperature, in Celsius, is the value on the Fahrenheit scale exactly doubled?
a. 160.0°
b. −160°
c. −54.0°
d. 17.8°
e. 22.2°

ANS: A DIF: Difficult REF: 1.8
OBJ: Distinguish between and convert Fahrenheit, Celsius, and Kelvin temperatures.
MSC: Evaluating

123. At what temperature do the Kelvin and Fahrenheit scales have the same value?
a. 129.30°
b. 301.43°
c. 574.58°
d. 654.59°
e. There is no temperature at which the two scales have the same value.

ANS: C DIF: Difficult REF: 1.8
OBJ: Distinguish between and convert Fahrenheit, Celsius, and Kelvin temperatures.
MSC: Evaluating

124. A scientist creates a new temperature scale with units of "°I" by setting the melting and boiling points of iodine to be 0°I and 100°I, respectively. On the Celsius scale, iodine melts at 113.7°C and boils at 184.3°C. What is the formula to convert from °I to degrees Celsius (°C)?
a. $°\mathrm{C} = \left(\frac{100}{70.6}\right)°\mathrm{I} + 113.7$
b. $°\mathrm{C} = \left(\frac{70.6}{100}\right)(°\mathrm{I} - 113.7)$
c. $°\mathrm{C} = \left(\frac{184.3}{113.7}\right)(°\mathrm{I} - 113.7)$
d. $°\mathrm{C} = \left(\frac{184.3}{113.7}\right)°\mathrm{I} + 113.7$
e. $°\mathrm{C} = \left(\frac{70.6}{100}\right)°\mathrm{I} + 113.7$

ANS: A DIF: Difficult REF: 1.8
OBJ: Distinguish between and convert Fahrenheit, Celsius, and Kelvin temperatures.
MSC: Creating

SHORT ANSWER

1. Two compounds containing nitrogen and oxygen are analyzed. Compound 1 yields 8.76 g N for every 10.0 g O. Compound 2 yields 17.5 g N for every 10.0 g O. Do these masses support the law of multiple proportions? Support your answer quantitatively.

   ANS:
   Yes, these masses support the law of multiple proportions.
   The mass of N in compound 2 should be a small whole-number multiple of that in compound 1.
   Comparing these values quantitatively: 17.5 / 8.76 = 1.9988 = 2.00.

   DIF: Moderate REF: 1.1 OBJ: Describe the law of multiple proportions.
   MSC: Analyzing

2. A sample of MnO is found to contain 5.00 g O and 17.2 g Mn. Find the mass of oxygen in a sample of MnO_2 containing 16.6 g Mn.

   ANS:
   9.67 g O
   The O-to-Mn mass ratio in MnO_2 should be twice that of MnO.
   MnO: 5.00 g/17.2 g = 0.291; MnO_2 x g/16.6 = 0.582 gives x = 9.67 g O.

   DIF: Difficult REF: 1.1 OBJ: Describe the law of multiple proportions.
   MSC: Evaluating

3. Two compounds containing nitrogen and oxygen are analyzed. Compound 1 is 63.65% nitrogen by mass and has the chemical formula N_2O. Compound 2 contains 1.713 g O for every 1.000 g N. What is the chemical formula of compound 2?

   ANS:
   N_2O_3
   N_2O contains 0.571 g O for every gram of N. 1.713 divided by 0.571 equals 3, which means 2 contains three times more O relative to N than 1. If the Compound is 63.65% nitrogen, it is 36.35% oxygen, by mass. The ratio of oxygen to nitrogen is (36.35 g O/63.65 g N) = 0.5711 g O/1.000 g N.
   since 1.713/0.5711/3, then Compand 2 contains three times as many oxygen relative to nitrogen as does Compound 1.

   DIF: Difficult REF: 1.1 OBJ: Describe the law of multiple proportions.
   MSC: Evaluating

4. Label each of the following as either a pure substance or a mixture: yellow mustard, bromine liquid, molten iron, gasoline, air.

   ANS:
   pure substance: bromine liquid, molten iron
   mixture: yellow mustard, gasoline, air

   DIF: Easy REF: 1.3 OBJ: Distinguish between pure substances and mixtures.
   MSC: Remembering

5. Label each of the following as either a pure substance or a mixture: concrete, orange juice, steam, helium gas, seawater.

   ANS:
   pure substance: steam, helium gas
   mixture: concrete, orange juice, seawater

   DIF: Easy REF: 1.3 OBJ: Distinguish between pure substances and mixtures.
   MSC: Remembering

6. Label the following as either a homo- or heterogeneous mixture: gasoline, air, a slice of sourdough bread, sweet tea, vodka, smoke.

   ANS:
   homogeneous: gasoline, air, sweet tea, vodka
   heterogeneous: a slice of sourdough bread, smoke

   DIF: Easy REF: 1.3
   OBJ: Distinguish between homogeneous and heterogeneous mixtures.
   MSC: Remembering

7. Correctly label the following as physical or chemical properties of copper metal.
   A. Copper metal conducts heat.
   B. Copper metal reacts with nitric acid to produce copper(II) nitrate.
   C. Copper metal melts at 1085°C.
   D. Copper metal conducts electricity.
   E. Copper metal has an orange color.
   F. A green-blue substance forms on copper surfaces exposed to air.
   G. Copper is malleable and ductile.

   ANS:
   physical properties: A, C, D, E, G
   chemical properties: B, F

   DIF: Easy REF: 1.3
   OBJ: Describe and give examples of chemical and physical properties.
   MSC: Remembering

8. Label the following as physical or chemical properties of potassium.
   A. It is a soft, shiny metal.
   B. It oxidizes rapidly in air.
   C. It reacts vigorously in water to produce hydrogen gas.
   D. Its density at room temperature is lower than that of water.
   E. It has a fairly low melting point of 63.38°C.

   ANS:
   physical properties: A, D, E
   chemical properties: B, C

   DIF: Easy REF: 1.3
   OBJ: Describe and give examples of chemical and physical properties.
   MSC: Remembering

9. For each of the following, indicate whether a physical or chemical change occurs.
   A. Mercury(II) oxide is heated and forms mercury metal (Hg) and oxygen gas (O_2).
   B. Liquid mercury is cooled to −40°C, at which point it solidifies.
   C. A glowing match is thrust into hot oxygen gas and bursts into flame.
   D. Water vapor condenses on a cool surface.

   ANS:
   physical change: B, D
   chemical change: A, C

   DIF: Moderate REF: 1.3
   OBJ: Distinguish between physical and chemical changes. MSC: Analyzing

10. For each of the following, indicate whether a physical or chemical change occurs.
   A. A mixture of solid iodine (I_2) and table salt (NaCl) is heated until the iodine vaporizes.
   B. Iodine vapor is condensed in a cool glass beaker.
   C. A mixture of solid iodine and zinc metal is ignited and forms solid zinc iodide (ZnI_2).
   D. Electrical current is passed through zinc iodide to generate zinc metal and iodine vapor.

   ANS:
   physical change: A, B
   chemical change: C, D

   DIF: Moderate REF: 1.3
   OBJ: Distinguish between physical and chemical changes. MSC: Analyzing

11. For each of the following, indicate whether a physical or chemical change occurs.
    A. Solid table salt is obtained from the evaporation of seawater.
    B. Alcohol is boiled off from rum.
    C. Mercury vapor is generated by heating mercury(II) oxide.
    D. Oxygen is removed from an iron oxide containing Fe_2O_3.
    E. Gold metal is separated from river sand by panning.

    ANS:
    physical change: A, B, E
    chemical change: C, D

    DIF: Moderate REF: 1.3
    OBJ: Distinguish between physical and chemical changes. MSC: Analyzing

12. Identify the following—first, as physical or chemical properties and second, as intensive or extensive properties: flammability, density, volume, color, boiling point, mass, conductivity, volatility, hardness, resistance to acids.

    ANS:
    Flammability and resistance to acids are chemical properties; the remaining are physical properties. Volume and mass are extensive properties; the remaining are intensive properties.

    DIF: Difficult REF: 1.3
    OBJ: Describe and give examples of extensive and intensive properties.
    MSC: Analyzing

13. In relation to their constituent particles, arrange the phases of matter (solid, liquid, and gas) in order of increasing compressibility, rigidity, proximity to neighbors, attractive forces between particles, and freedom to move.

    ANS:
    compressibility: g > l > s
    rigidity: s > l > g
    proximity to neighbors: s > l > g
    attractive forces between particles: s > l > g
    freedom to move: g > l > s

    DIF: Easy REF: 1.4
    OBJ: Distinguish between the states of matter: solid, liquid, and gas.
    MSC: Remembering

14. Six phase transitions were discussed in chapter 1: melting, freezing, vaporization, condensation, sublimation, and deposition. Given equal masses of water, which changes require energy to be added? Which transition releases the greatest amount of energy? Does it take more energy to melt or to vaporize water, and why?

ANS:
The changes requiring energy are melting, vaporization, and sublimation.
The transition releasing the greatest amount of energy is deposition.
It takes more energy to vaporize water because water molecules must be completely separated from one another.

DIF: Moderate REF: 1.4
OBJ: Describe the processes of sublimation, melting, vaporization, condensation, freezing, and deposition. MSC: Analyzing

15. State the law of conservation of energy.

ANS:
Energy cannot be created or destroyed, but it can be converted from one form to another.
OR, The total energy in the universe is constant.

DIF: Easy REF: 1.5 OBJ: State the law of conservation of energy.
MSC: Remembering

16. Label the following as examples of kinetic energy or potential energy:
a soccer ball on a closet shelf
electrons flowing through a wire
chemical bonds in a carbohydrate
steam expanding in a piston

ANS:
potential energy: a soccer ball on a closet shelf, chemical bonds in a carbohydrate
kinetic energy: electrons flowing through a wire, steam expanding in a piston

DIF: Easy REF: 1.5 OBJ: Distinguish between potential and kinetic energy.
MSC: Analyzing

17. The potential energy associated with gravity can be expressed as PE = mgh, where m is the mass of the object, g is the acceleration due to gravity, and h is the height of the object. On Earth, the acceleration due to gravity is 9.8 m/s^2. Calculate the potential energy of a 5.45 kg bowling ball that is sitting 1.0 m above the ground on Earth. If the potential energy of the bowling ball 1.0 m above the surface of the moon is 8.7 kg m^2/s^2, what is the gravitational acceleration on the moon?

ANS:
53 kg m^2/s^2, 1.6 m/s^2

PE on Earth = (5.45 kg)(9.8 m/s^2)(1.0 m) = 53 kg m^2/s^2
g of the moon = (8.7 kg m^2/s^2) / (1.0 m) / (5.45 kg) = 1.6 m/s^2

DIF: Moderate REF: 1.5 OBJ: Distinguish between potential and kinetic energy.
MSC: Applying

18. An electron can travel at speeds close to that of light, but its mass is very small (9.11×10^{-31} kg). A land snail may move at approximately 0.001 m/s but is more massive (0.035 g). How many times more kinetic energy does the snail have than an electron traveling at 2×10^8 m/s?

ANS:
1×10^6 times more kinetic energy

KE of the electron $= \frac{1}{2}(9.1110^{-31}\ \text{kg})(2 \times 10^8\ \text{m/s})^2 = 2 \times 10^{-14}\ \text{kgm}^2/\text{s}^2$
KE of the snail $= \frac{1}{2}(0.035\,\text{kg})(0.001\,\text{m/s})^2 = 2 \times 10^{-8}\ \text{kgm}^2/\text{s}^2$
$2 \times 10^{-8} / 2 \times 10^{-14} = 1 \times 10^6$, or a million times more

DIF: Difficult REF: 1.5 OBJ: Distinguish between potential and kinetic energy.
MSC: Analyzing

19. Perform the following calculation and report the answer to the correct number of significant figures.

$$6.1 \times \frac{1870}{2.60 \times 10^5} - \frac{7.43 \times 10^{-3}}{5.200}$$

ANS:
4.2×10^{-2}

$$6.1 \times \frac{1870}{2.60 \times 10^5} - \frac{7.43 \times 10^{-3}}{5.200} = 4.4 \times 10^{-2} - 1.43 \times 10^{-3} = 4.2 \times 10^{-2}$$

Round multiplication/division to the least number of significant figures; round addition/subtraction to the least precise decimal place.

DIF: Moderate REF: 1.7
OBJ: Apply the rules for significant figures (weak-link principle).
MSC: Applying

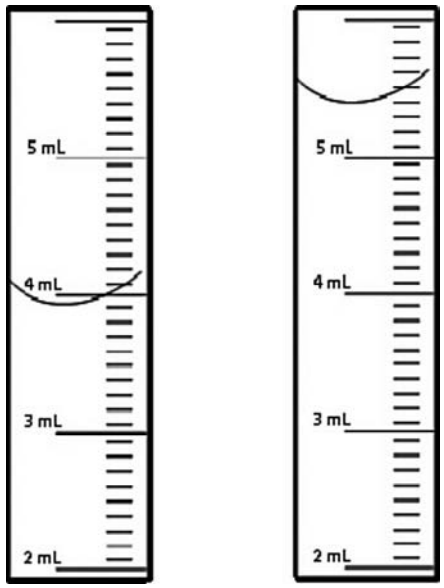
20. A 50.0 g piece of iron is submerged in a graduated cylinder containing 25.00 mL water, and the liquid level rises to 31.35 mL. If a 68.0 g sample of iron is added to a graduated cylinder containing 25.00 mL water, what is the final volume reading?

ANS:
33.64 mL

density of Fe: 50.0 g/6.35 mL = 7.87 g/mL
68.0 g Fe / 7.87 g/mL = 8.64 mL Fe, so the final volume reading would be 25.00 + 8.64 = 33.64 mL

DIF: Moderate REF: 1.7
OBJ: Apply the rules for significant figures (weak-link principle).
MSC: Applying

21. The volume of an irregularly shaped silver-colored metal is determined using water displacement. The graduated cylinders below show the level before (*left*) and after (*right*) the object is submerged. The mass of the metal is 15.2 g. Determine the metal's density. Report your answers to the correct number of significant figures.



ANS:
10.1 g/mL (or 10.1 g/cm^3)

$$\frac{15.2\text{ g}}{5.40\text{ mL} - 3.90\text{ mL}} = 10.1\text{ g/mL}$$

DIF: Moderate REF: 1.7
OBJ: Apply the rules for significant figures (weak-link principle).
MSC: Applying

22. An empty 25.00 mL volumetric flask has a mass of 20.550 g. When it is partially filled with metal pellets, the mass is 130.278 g. The flask is then filled to the mark with methanol (density = 0.7918 g/mL), and the total mass of the flask, metal, and methanol is 142.419 g. Calculate the density of the metal pellets.

ANS:
11.4 g/mL

mass of metal:	130.278 g – 20.550 g = 109.728 g
mass of methanol:	142.419 g – 130.278 g = 12.141 g
volume of methanol:	12.141 g / 0.7918 g/mL = 15.33 mL
volume of metal:	25.00 mL – 15.33 mL = 9.67 mL
density of metal:	109.728 g/9.67 mL = 11.347… g/mL = 11.3 g/mL

DIF: Difficult REF: 1.7
OBJ: Apply the rules for significant figures (weak-link principle).
MSC: Evaluating

23. You are given three cut gemstones, all having a mass of about 2.5 g but with different cuts (shapes). One you know to be a diamond. You must determine which of the other two is diamond and which is cubic zirconia. On the surface, all three appear the same. They are transparent and they sparkle. The only equipment available is a balance that reads to 0.01 g, a set of graduated cylinders, a thermometer, a ruler, a hot plate, sandpaper, and forceps.

How would you identify the "impostor" diamond? What important factor would you have to consider while doing your assessment?

ANS:
With the equipment available, it would be simple to find the density of each stone. The densities of the two diamonds should be identical (or very close). The density of diamond would have to be sufficiently different from that of cubic zirconia for this method to work. This condition is met: $\rho_{\text{diamond}} = 3.52\ \text{g/cm}^3$; $\rho_{\text{cubic zirconia}} = 5.6 - 6.0\ \text{g/cm}^3$.

DIF: Difficult REF: 1.7 OBJ: Use density in calculations.
MSC: Creating

24. The mass and volume of Jupiter are 1.90×10^{27} kg and 1.43×10^{30} cm^3. Jupiter's mass is about 318 times greater than Earth's, and its volume is 1321 times greater. Calculate the approximate densities of Jupiter and of Earth and report your answers to the correct number of significant figures.

ANS:
1.33 g/cm^3 and 5.54 g/cm^3

$$Jupiter: \frac{1.90 \times 10^{27}\,\text{kg} \times \left(\frac{1000g}{1\text{kg}}\right)}{1.43 \times 10^{30}\ \text{cm}^3} = 1.33g/\text{cm}^3$$

$$Earth: \frac{\left(1.90 \times 10^{30}\,\text{g}\right) \times \left(\frac{1}{318}\right)}{\left(1.43 \times 10^{30}\ \text{cm}^3\right) \times \left(\frac{1}{1320}\right)} = \frac{5.98 \times 10^{27}\,\text{g}}{1.08 \times 10^{27}\,\text{cm}^3} = 5.54\,\text{g}/\text{cm}^3$$

DIF: Difficult REF: 1.7
OBJ: Apply the rules for significant figures (weak-link principle).
MSC: Evaluating

25. Tungsten metal has a very high melting point of 3422°C. What is the melting point of in degrees Fahrenheit? Kelvin?

ANS:
6192°F; 3695 K

°F = (1.8)(°C) + 32 = 6192°F.
K = °C + 273.15 = 3695 K.

DIF: Easy REF: 1.8
OBJ: Distinguish between and convert Fahrenheit, Celsius, and Kelvin temperatures.
MSC: Remembering

26. A 75 lb. child is to receive 1.5 mg/kg of an anti-inflammatory medication. A suspension containing the medication is available, and its label lists 75 mg/2.0 mL of the active ingredient. How many milliliters should be given to the child? (1 kg = 2.2 lb.)

ANS:
1.4 mL

$$75\text{ lb} \times \frac{1\text{ kg}}{2.2\text{ lb.}} \times \frac{1.5\text{ mg}}{1\text{ kg}} \times \frac{2.0\text{ mL}}{75\text{ mg}} = 1.4\text{ mL}$$

DIF: Moderate REF: 1.8
OBJ: Use the unit-factor method to convert measurements. MSC: Applying

27. A 13 g piece of dark chocolate is found to contain 14 mg caffeine, while the caffeine content in a 20 fl oz mug of coffee might be 415 mg. How many pounds of chocolate would you have to eat to consume the amount of caffeine in two mugs of this particular coffee? (1 lb. = 453.6 g)

ANS:
1.7 lb.

$$2\text{ mugs} \times \frac{415\text{ mg caffeine}}{1\text{ mug coffee}} \times \frac{13\text{ g chocolate}}{14\text{ mg caffeine}} \times \frac{1\text{ lb.}}{453.6\text{g}} = 1.7\text{ lb.}$$

DIF: Moderate REF: 1.8
OBJ: Use the unit-factor method to convert measurements. MSC: Applying

28. A cesium atomic clock is extremely accurate. If a particular clock has a measured accuracy of 2 nanoseconds per day, how many years would correspond to an uncertainty of 1 minute?

ANS:
8×10^7 years, or 80 million years

$$1\text{ min} \times \frac{60\text{ s}}{1\text{ min}} \times \frac{1 \times 10^9\text{ ns}}{1\text{ s}} \times \frac{1\text{ day}}{2\text{ ns}} \times \frac{1\text{ yr}}{365\text{ days}} = 8 \times 10^7\text{ yr}$$

DIF: Moderate REF: 1.8
OBJ: Use the unit-factor method to convert measurements. MSC: Analyzing

29. The United States covers about 3.8 million square miles (3.8×10^6 mi^2). If the base of a classic Lego® block measures 3.18 cm × 1.58 cm, about how many blocks would be required to cover the United States?
(1 mi = 1609 m.)

ANS:
2.0×10^{16} blocks

area of a block: $3.18 \times 1.58 = 5.02$ cm^2

$$3.8 \times 10^6 \text{ mi}^2 \times \left(\frac{1609 \text{ m}}{1 \text{ mi}}\right)^2 \times \left(\frac{100 \text{ cm}}{1 \text{ m}}\right)^2 \times \frac{1 \text{ block}}{5.02 \text{ cm}^2} = 2.0 \times 10^{16} \text{ blocks}$$

DIF: Moderate REF: 1.8
OBJ: Use the unit-factor method to convert measurements. MSC: Applying

30. Cesium has a melting point of 302 K and a boiling point of 944 K. What is the physical state of cesium when the temperature of the surroundings is 68°F?

ANS:
Cesium would be a solid at 68°F.

°C = (68°F – 32) / 1.8 = 20°C.
20°C is 293 K, which is just under the melting point. The cesium is in the solid phase.

DIF: Moderate REF: 1.8
OBJ: Distinguish between and convert Fahrenheit, Celsius, and Kelvin temperatures.
MSC: Analyzing

31. A beaker of water at 298 K is heated for 20.0 minutes at a rate that produced a temperature change of 1.50°F per minute. What is the final temperature of the water in degrees Celsius?

ANS:
42°C

298 K = 25°C; °F = 1.8°C + 32 = 77°F.
(20.0 minutes)(1.50°F/minute) = 30.0°F increase so final T in °F = 107°F.
°C = (°F – 32) /1.8 = 42°C.

DIF: Difficult REF: 1.8
OBJ: Distinguish between and convert Fahrenheit, Celsius, and Kelvin temperatures.
MSC: Evaluating

32. A scientist creates a new temperature scale with units of "°Cs" by setting 0°Cs and 100°Cs to the melting and boiling points of cesium. On the Celsius scale, cesium melts at 29°C and boils at 671°C. Give the formulas to convert °Cs to degrees Celsius and degrees Celsius to °Cs.

ANS:

$$°\mathrm{Cs} \; = \; \frac{50}{321}\,(°\mathrm{C} - 29).$$

$$°\mathrm{C} \; = \; \frac{321}{50}\,°\mathrm{Cs} + 29.$$

DIF: Difficult REF: 1.8
OBJ: Distinguish between and convert Fahrenheit, Celsius, and Kelvin temperatures.
MSC: Creating

Chapter 2: Atoms, Ions, and Molecules—The Building Blocks of Matter

LEARNING OBJECTIVES

Describe how cathode rays are generated and behave in magnetic/electric fields.

Explain how the mass-to-charge ratio of the electron was determined.

Explain how the charge on the electron was determined.

Write notation for charged species (cations and anions).

Describe the plum-pudding model of the atom.

Define and describe types of radioactivity.

Describe Rutherford's experiment that discovered the atomic nucleus and the subsequent view of atomic structure.

Compare the mass and charge of subatomic particles: electrons, protons, and neutrons.

Describe the experiment that discovered isotopes.

Define isotope, atomic number, nuclide, nucleons, and mass number.

Compare Dalton's definition of an element to the definition that realizes the existence of isotopes.

Interpret and write symbols for nuclides, identify nuclides from mass numbers and atomic numbers, and determine their charges from the number of electrons.

Explain how the periodic table is organized.

Describe the features of Mendeleev's periodic table.

Determine charge from the position of an element in the periodic table.

Identify on the periodic table: groups, periods, metals, metalloids, nonmetals, representative elements, transition metals, alkali metals, alkaline earth metals, halogens, and noble gases.

Compute the average atomic masses using the natural abundances of isotopes for an element.

Compute the molecular mass from a formula.

Calculate the mass of an atom in grams from atomic mass units (amu).

Define a mole; convert between moles and numbers of atoms/molecules.

Determine the molar mass/formula mass of a substance using the periodic table.

Use molar mass to convert between the mass and moles of a substance.

Describe how a mass spectrometer can be used to determine the molar mass of a substance; run a mass spectrum; identify the molecular ion peak.

Explain how mass spectrometry can be used to identify a substance.

Explain how mass spectrometry can be used to measure isotopic abundances.