# Chapter 1: Matter, Energy, and the Origins of the Universe

**MULTIPLE CHOICE**

1.  Which one of the following is a mixture?

    a.  an aqueous solution of sugar
    b.  pure water
    c.  nitrogen gas
    d.  copper metal
    e.  table salt (sodium chloride)

    ANS:  A            DIF:  Easy            REF:  1.1
    OBJ:  Distinguish between pure substances, mixtures, elements, and compounds.
    MSC:  Conceptual

2.  The law of constant composition states that _____

    a.  compounds such as $NO_2$ and $SO_2$ have identical chemical properties.
    b.  for a given compound, the elements forming the compound always react in the same proportions.
    c.  nitrogen and oxygen can combine to form NO or $NO_2$.
    d.  elements do not always combine in the same proportion to give the same compound.
    e.  only one compound can be produced when two elements combine.

    ANS:  B            DIF:  Easy            REF:  1.1
    OBJ:  Describe how a compound is an example of the law of constant composition.
    MSC:  Factual

3.  A pure substance _____

    a.  cannot be separated into simpler substances by physical means.
    b.  can have a composition that varies from sample to sample.
    c.  must be an element.
    d.  has different chemical and physical properties depending on its source.
    e.  must be a compound.

    ANS:  A            DIF:  Easy            REF:  1.1
    OBJ:  Identify the characteristics of a pure substance.            MSC:  Conceptual

4.  An element _____

    a.  can be separated into its components by physical methods.
    b.  may have different chemical properties depending on its source.
    c.  cannot be separated into simpler substances by chemical methods.
    d.  can also be a compound.
    e.  exists only as atoms and not as molecules.

    ANS:  C            DIF:  Easy            REF:  1.1
    OBJ:  Identify the characteristics of an element.            MSC:  Conceptual

5.  Which of the following is not a pure substance?

    a.  air
    b.  nitrogen gas
    c.  oxygen gas
    d.  argon gas
    e.  table salt (sodium chloride)

    ANS:  A            DIF:  Easy            REF:  1.1
    OBJ:  Distinguish between pure substances, mixtures, elements, and compounds.
    MSC:  Conceptual

6.  Which of the following is a pure substance?

    a.  mineral water
    b.  blood
    d.  sucrose (table sugar)
    e.  beer

    c.    brass (an alloy of copper and zinc)

ANS:  D             DIF:   Easy          REF:   1.1
OBJ:   Distinguish between pure substances, mixtures, elements, and compounds.
MSC:  Conceptual

7.   Which of the following is an element?

    a.   $Cl_2$                                       d.   MgO
    b.   $H_2O$                                     e.   HCl
    c.   NaCl

ANS:  A             DIF:   Easy          REF:   1.1
OBJ:   Distinguish between pure substances, mixtures, elements, and compounds.
MSC:  Conceptual

8.   A structural formula _____

    a.   always shows correct bond distances and angles in a molecule.
    b.   is the same as a chemical formula.
    c.   shows how the molecule can be synthesized.
    d.   shows how atoms are connected in a chemical species.
    e.   is the same as a molecular formula.

ANS:  D             DIF:   Easy          REF:   1.2
OBJ:   Describe the information provided by a structural formula.      MSC:  Factual

9.   Which of the following is a homogeneous mixture?

    a.   filtered water                        d.   trail mix snack
    b.   chicken noodle soup            e.   fruit salad
    c.   clouds

ANS:  A             DIF:   Easy          REF:   1.1
OBJ:   Identify the characteristics of a homogeneous mixture.      MSC:  Conceptual

10.   Which of the following is a heterogeneous mixture?

    a.   air                                  d.   brass
    b.   sugar dissolved in water        e.   table salt (sodium chloride)
    c.   muddy river water

ANS:  C             DIF:   Easy          REF:   1.1
OBJ:   Identify the characteristics of a heterogeneous mixture.      MSC:  Conceptual

11.   Distillation may be used to separate components in a mixture based on differences in _____

    a.   solubilities.                       d.   masses.
    b.   boiling points.                  e.   color.
    c.   melting points.

ANS:  B             DIF:   Easy          REF:   1.3
OBJ:   Describe the process of distillation.    MSC:  Factual

12.   Which of the following mixtures can be separated by filtration?

    a.   sugar dissolved in coffee       d.   alcohol dissolved in water
    b.   sand and water                e.   air
    c.   gasoline

ANS:  B             DIF:   Easy          REF:   1.3
OBJ:   Describe the process of filtration.    MSC:  Conceptual

13.   An example of a chemical property of formaldehyde ($CH_2O$) is _____

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: 1.4
OBJ: Distinguish between physical and chemical properties.          MSC: Conceptual

14. Which represents an intensive property?

a. Hydrogen gas has mass.
b. Hydrogen gas has a given density.
c. A balloon filled with hydrogen gas has a given volume.
d. Hydrogen releases a given amount of energy when it reacts with oxygen.
e. Hydrogen gas in a steel tank exerts a given pressure.

ANS: B          DIF: Medium          REF: 1.4
OBJ: Distinguish between intensive and extensive properties.          MSC: Conceptual

15. Which of the following is a chemical property?

a. Hydrogen is flammable.
b. Hydrogen is a gas.
c. Hydrogen gas has mass.
d. The boiling point of hydrogen is 20 K.
e. Hydrogen gas exerts pressure on the walls of a container.

ANS: A          DIF: Easy          REF: 1.4
OBJ: Distinguish between physical and chemical properties.          MSC: Conceptual

16. Extensive properties are _____

a. physical properties and not chemical properties.
b. identical for all substances.
c. independent of the volume of substance present.
d. dependent on the amount of substance.
e. dependent on factors external to the substance itself.

ANS: D          DIF: Medium          REF: 1.4
OBJ: Distinguish between intensive and extensive properties.          MSC: Conceptual

17. The density of an object that weighs 10.0 g and occupies a volume of 2.5 cm$^3$ is _____

a. 4.0 g/cm$^3$.
b. 4.0 cm$^3$/g.
c. 0.25 g/cm$^3$.
d. 0.25 cm$^3$/g.
e. dependent on the temperature.

ANS: A          DIF: Easy          REF: 1.4
OBJ: Use density correctly in analysis and calculations.          MSC: Applied

18. Which of the following represents a chemical property 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.

ANS: B          DIF: Easy          REF: 1.4
OBJ: Distinguish between physical and chemical properties.          MSC: Conceptual

19. Which of the following represents a physical property of water?

a. Water boils at 100°C.
b. An electrical current decomposes water into hydrogen gas and oxygen gas.

c.  Water reacts with iron metal and oxygen to form rust.
d.  Water reacts with carbon monoxide to form carbon dioxide and hydrogen gas.
e.  Water is used in photosynthesis.

ANS:  A            DIF:  Easy            REF:  1.4
OBJ:  Distinguish between physical and chemical properties.            MSC:  Conceptual

20. When you place a piece of dry ice (solid carbon dioxide) on a plate, you notice that no liquid forms, unlike ice that melts to form liquid water. This is because dry ice _____

a.  as a liquid quickly evaporates.            d.  in the liquid form does not exist.
b.  undergoes deposition instead of melting.            e.  contains no water.
c.  sublimes instead of melting.

ANS:  C            DIF:  Easy            REF:  1.6
OBJ:  Identify the processes that accompany phase transitions.            MSC:  Applied

21. Which statement correctly describes the properties of a gas?

a.  A gas does not occupy the entire volume of the container and is not highly compressible.
b.  A gas occupies the entire volume of the container and is highly compressible.
c.  A gas is highly ordered, and the molecules do not move about in the container.
d.  A gas has a definite volume and shape.
e.  A gas takes the shape of the container but is not highly compressible.

ANS:  B            DIF:  Easy            REF:  1.6
OBJ:  Identify the characteristics of a gas.            MSC:  Factual

22. A hypothesis is _____

a.  supported by experimental evidence.
b.  a scientific theory used to explain observations.
c.  an explanation of observed processes that needs to be tested.
d.  the entire process through which scientific phenomena are explained.
e.  one side of a right triangle.

ANS:  C            DIF:  Easy            REF:  1.7            OBJ:  Characterize a hypothesis.
MSC:  Factual

23. John Dalton postulated that all matter is composed of small particles called atoms. For this proposition to be considered a valid scientific theory, _____

a.  it must be continually supported by experimental evidence and testing.
b.  it must be impossible to prove wrong by experiment.
c.  all possible experiments must never find an exception to it.
d.  some, but only a few, experiments may find exceptions to it.
e.  it must be voted on by the scientific community and accepted by all.

ANS:  A            DIF:  Medium            REF:  1.7
OBJ:  Characterize the scientific method.            MSC:  Factual

24. Which of the following is the SI base unit for mass?

a.  g            d.  lb
b.  kg            e.  m
c.  mg

ANS:  B            DIF:  Easy            REF:  1.8
OBJ:  Name the SI base units, their abbreviations, and the relevant quantities.
MSC:  Factual

25. Which of the following is the most massive?

a.  2.5 kg of oxygen gas            d.  250 g of helium gas

b.   0.25 kg of iron                                     e.   250 mg of aluminum
c.   2.5 g of sodium chloride (table salt)

ANS:  A                DIF:   Easy                REF:   1.8
OBJ:   Correctly use prefixes with SI base units.                              MSC:   Conceptual

26.   The diameter of the sun is 1,390,000 km. In scientific notation this is

a.   $1.39 \times 10^{-6}$ km                          d.   $1.39 \times 10^{3}$ km
b.   $1.39 \times 10^{-3}$ km                          e.   $1.39 \times 10^{8}$ m
c.   $1.39 \times 10^{6}$ km

ANS:  C                DIF:   Easy                REF:   1.8
OBJ:   Correctly use exponential notation with SI units.                MSC:   Applied

27.   Electromagnetic radiation in the mid-infrared region of the spectrum has wavelengths around 10.6 $\mu$m. Express
this wavelength in meters using exponential notation (1 $\mu$m = $10^{-6}$ m).

a.   $1.06 \times 10^{-6}$ m                           d.   $1.06 \times 10^{7}$ m
b.   $1.06 \times 10^{-5}$ m                           e.   $1.06 \times 10^{5}$ m
c.   1.06 m

ANS:  B                DIF:   Easy                REF:   1.8
OBJ:   Correctly use exponential notation with SI units.                MSC:   Applied

28.   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, 1.522 g                          d.   1.513 g, 1.517 g, 1.512 g
b.   1.513 g, 1.511 g, 1.450 g                          e.   1.513 mg, 1.510 mg, 1.523 mg
c.   1.513 g, 1.459 g, 1.533 g

ANS:  D                DIF:   Easy                REF:   1.8
OBJ:   Identify the precision in measurements.                       MSC:   Applied

29.   As a summer intern at the National Institute of Standards and Technology, a student performed three
measurements to determine the density of water at 25°C to four significant figures. She obtained the following
results. The known density of water at 25°C to three significant figures is 0.958 g/mL.

| Trial | Density (g/mL) |
|-------|----------------|
| 1     | 0.9345         |
| 2     | 0.9523         |
| 3     | 0.9107         |

The measurements were _____

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

ANS:  D                DIF:   Medium              REF:   1.8
OBJ:   Distinguish between precision and accuracy.                    MSC:   Conceptual

30.   As a summer intern at the National Institute of Standards and Technology, a student performed three
measurements to determine the density of water at 25°C to four significant figures. She obtained the following
results. The known density of water at 25°C to three significant figures is 0.958 g/mL.

| Trial | Density (g/mL) |
|-------|----------------|
| 1     | 0.9345         |
| 2     | 0.9346         |
| 3     | 0.9348         |

The measurements were _____

a.   sufficiently precise but not accurate.              d.   neither sufficiently precise nor accurate.

   b.   sufficiently accurate but not precise.          e.   not repeated an adequate number of times.
   c.   both sufficiently precise and accurate.

ANS:  A               DIF:   Medium       REF:   1.8
OBJ:   Distinguish between precision and accuracy.              MSC:  Conceptual

31.  The density of iron is 7.9 g/cm$^3$. What is the volume of a 4.5 kg iron block?

   a.   570 cm$^3$                        d.   35.6 cm$^3$
   b.   0.570 cm$^3$                    e.   1.76 cm$^3$
   c.   $3.56 \times 10^4$ cm$^3$

ANS:  A               DIF:   Easy         REF:   1.4
OBJ:   Use density correctly in analysis and calculations.        MSC:  Applied

32.  Jupiter's mass is estimated to be $1.90 \times 10^{27}$ kg, and it has a diameter of 142,984 km. Assuming that Jupiter is spherical, estimate its density (the volume of a sphere is $4\pi r^3/3$).

   a.   0.620 g/cm$^3$                  d.   0.810 g/cm$^3$
   b.   1.61 g/cm$^3$                   e.   0.155 g/cm$^3$
   c.   1.24 g/cm$^3$

ANS:  C               DIF:   Difficult     REF:   1.4
OBJ:   Use density correctly in analysis and calculations.        MSC:  Applied

33.  Which of the following quantities has two significant figures?

   a.   0.4                            d.   0.0092
   b.   101                         e.   0.520
   c.   $1.10 \times 10^3$

ANS:  D               DIF:   Easy         REF:   1.8
OBJ:   Identify the number of significant figures in a number or measurement.
MSC:  Applied

34.  Given the following figure, which of the measurements listed is the best estimate of the length of the aluminum rod?



   a.   1.8 cm                        d.   1.9 cm
   b.   1.81 cm                    e.   2 cm
   c.   1.810 cm

ANS:  D               DIF:   Easy         REF:   1.8
OBJ:   Identify the number of significant figures in a number or measurement.
MSC:  Applied

35.  The concentration (in % by volume) of methyl *tert*-butyl ether (MTBE) was determined in four samples of the same gasoline. What is the average value, and which measurement was the most accurate, compared to the average?

| Sample | % (v/v) MTBE |
|--------|--------------|
| 1 | 5.01 |
| 2 | 4.95 |
| 3 | 5.10 |
| 4 | 5.15 |

a. 5.05, sample 1  
b. 5.05, sample 2  
c. 5.05, sample 3  
d. 5.05, sample 4  
e. 5.0525, sample 3  

ANS: A  DIF: Easy  REF: 1.8  
OBJ: Identify the accuracy in a set of measurements.  MSC: Applied

36. Indicate which of the following common laboratory devices will deliver 25 mL of a solution with the greatest precision.

a. a 50 mL Erlenmeyer flask (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 Erlenmeyer flask (without volume divisions)  
e. a 25 mL volumetric pipet (with a to deliver error of 0.01 mL at 25°C)  

ANS: E  DIF: Easy  REF: 1.8  
OBJ: Identify precision in measurements.  MSC: Applied

37. 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?



before          after
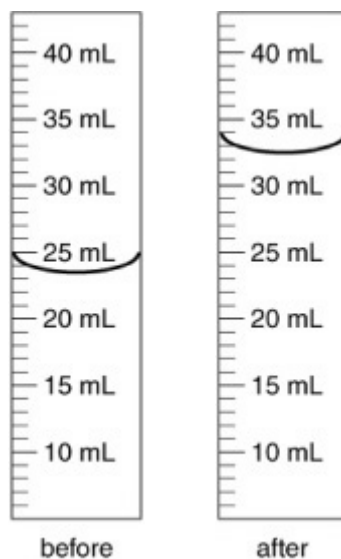
a. 2.8 g/cm$^3$  
b. 2.906 g/cm$^3$  
c. 0.782 g/cm$^3$  
d. 0.344 g/cm$^3$  
e. 2.734 g/cm$^3$  

ANS: A  DIF: Medium  REF: 1.8  
OBJ: Identify precision in measurements.  MSC: Applied

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

```
—0.00 mL
—1.00 mL
—2.00 mL
—3.00 mL
—4.00 mL
—5.00 mL
```

a. 5.4 mL                                    d. 4.3 mL
b. 5.40 mL                                   e. 4.30 mL
c. 4.60 mL

ANS:  C                  DIF:  Difficult        REF:  1.8
OBJ:  Identify precision in measurements.    MSC:  Applied

39. Which of the following is *not* a base SI unit?

a. cm                                        d. sec
b. m                                         e. mol
c. kg

ANS:  A                  DIF:  Easy            REF:  1.8
OBJ:  Name the SI base units, their abbreviations, and the relevant quantities.
MSC:  Factual

40. Which of the following is a derived SI unit?

a. m                                         d. $m^3$
b. kg                                        e. lb
c. $cm^3$

ANS:  D                  DIF:  Easy            REF:  1.8
OBJ:  Name the derived SI units, their abbreviations, and the relevant quantities.
MSC:  Factual

41. The summit of Mt. Humphreys, the highest point in Arizona, is 12,600 ft. How many meters is this?
   (1 m = 1.0936 yd)

a. 4593 m                                    d. 41,338 m
b. 3841 m                                    e. 37,800 m
c. 34,565 m

ANS:  B                  DIF:  Easy            REF:  1.9
OBJ:  Correctly convert between units using conversion factors.        MSC:  Applied

42. Cheetahs can run at speeds of up to 60 mi per hour. How many seconds does it take a cheetah to run 10 m at this
    speed? (1 mi = 1.609 km)

a. 0.37 s                                    d. 18 s
b. 0.10 s                                    e. 0.43 s
c. 56 s

ANS:  A                  DIF:  Medium          REF:  1.9
OBJ:  Correctly convert between units using conversion factors.        MSC:  Applied

43. In 1 second, light can travel $2.998 \times 10^8$ m. How many inches does light travel in 1 femtosecond (1 fs = $10^{-15}$ s, 1 inch = 2.54 cm)?

a.  118 in
b.  11.8 in
c.  1.18 in
d.  $1.18 \times 10^{-5}$ in
e.  $1.18 \times 10^{-7}$ in

ANS:  D   DIF:  Medium   REF:  1.9
OBJ:  Correctly convert between units using conversion factors.  MSC:  Applied

44. The density of quartz is 165 lb/ft³. A clear crystal with a mass of 26.5 g is found to displace 10.0 cm³ of water. The crystal has a density _____

a.  of 165 lb/ft³ and therefore is most likely quartz.
b.  of 2.65 g/cm³ and therefore is not quartz.
c.  of 170 lb/ft³ and might be quartz. Better measurements are needed for a definitive test.
d.  of $1.7 \times 10^2$ lb/ft³. Better measurements are needed for a definitive test.
e.  very different from that of quartz.

ANS:  A   DIF:  Difficult   REF:  1.9
OBJ:  Correctly convert between units using conversion factors.  MSC:  Applied

45. Spanish mahogany has a density of 53 lb/ft³. Would you be able to lift a piece of mahogany that measured 10 in × 12 in × 14 in?

a.  No, it would weigh approximately 200 lb.
b.  No, it would be too awkward.
c.  Yes, it would weigh approximately 25 lb.
d.  Yes, it would weigh approximately 50 lb.
e.  Yes, it would weigh approximately 5 lb.

ANS:  D   DIF:  Medium   REF:  1.9
OBJ:  Correctly convert between units using conversion factors.  MSC:  Applied

46. 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:  Easy   REF:  1.4
OBJ:  Use density correctly in analysis and calculations.  MSC:  Conceptual

47. What might be the air temperature on a really hot day?

a.  25°C
b.  273 K
c.  298 K
d.  40°C
e.  373 K

ANS:  D   DIF:  Easy   REF:  1.10
OBJ:  Convert between temperature scales: Kelvin, Celsius, and Fahrenheit.
MSC:  Conceptual

48. Liquid nitrogen boils at 77 K. What is this temperature in °F?

a.  −196°F
b.  −321°F
c.  −256°F
d.  −77°F
e.  −352°F

ANS:  B   DIF:  Medium   REF:  1.10
OBJ:  Convert between temperature scales: Kelvin, Celsius, and Fahrenheit.
MSC:  Applied

49. Room temperature is often taken to be 25°C. What is this temperature in °F?

a. 46°F　　　　　　　　　　　　　d. 77°F
b. 45°F　　　　　　　　　　　　　e. 72°F
c. 14°F

ANS:　D　　　　　　　DIF:　Easy　　　　　REF:　1.10
OBJ:　Convert between temperature scales: Kelvin, Celsius, and Fahrenheit.
MSC:　Applied

50. On a summer day, the temperature in Phoenix, Arizona, was recorded as 110°F. What is this temperature in °C?

a. 43°C　　　　　　　　　　　　　d. 93°C
b. 78°C　　　　　　　　　　　　　e. 29°C
c. 166°C

ANS:　A　　　　　　　DIF:　Easy　　　　　REF:　1.10
OBJ:　Convert between temperature scales: Kelvin, Celsius, and Fahrenheit.
MSC:　Applied

51. The temperature of the surface of the sun is 5800 K. What is this in °F?

a. 5495°F　　　　　　　　　　　　d. 3103°F
b. 5527°F　　　　　　　　　　　　e. 10,899°F
c. 9981°F

ANS:　C　　　　　　　DIF:　Medium　　　REF:　1.10
OBJ:　Convert between temperature scales: Kelvin, Celsius, and Fahrenheit.
MSC:　Applied

52. At what temperature do the Celsius and Fahrenheit scales read the same?

a. 40°
b. $-40°$
c. 11.4°
d. $-11.4°$
e. There is no temperature at which the two scales read the same.

ANS:　B　　　　　　　DIF:　Difficult　　REF:　1.10
OBJ:　Convert between temperature scales: Kelvin, Celsius, and Fahrenheit.
MSC:　Applied

53. Using _____, scientists can image individual atoms and molecules on a surface.

a. transmission microscopy　　　　　d. magnetic resonance
b. electron microscopy　　　　　　　e. X-ray spectroscopy
c. scanning tunneling microscopy

ANS:　C　　　　　　　DIF:　Easy　　　　　REF:　1.2
OBJ:　Identify a technique that enables scientists to produce images of atoms and molecules.
MSC:　Factual

54. Deposition is the process in which a _____ is converted into a _____.

a. liquid; solid　　　　　　　　　　d. liquid; gas
b. gas; liquid　　　　　　　　　　　e. solid; liquid
c. gas; solid

ANS:　C　　　　　　　DIF:　Easy　　　　　REF:　1.6
OBJ:　Identify the processes that accompany phase transitions.　　　MSC:　Factual

55. An object weighing 25.00 g has a volume of 9.3 $cm^3$. What is the density of the object?

a. 2.688 $g/cm^3$　　　　　　　　　d. 2.6882 $g/cm^3$
b. 2.68 $g/cm^3$　　　　　　　　　　e. 2.6881720 $g/cm^3$
c. 2.7 $g/cm^3$

ANS: C          DIF: Medium          REF: 1.8
OBJ: Report results of multiplication and division calculations to the correct number of significant figures.
MSC: Applied

56. Which one of the following statements is *not* correct?

    a. Helium is an element.
    b. Table salt (sodium chloride) is a compound.
    c. Water is a pure substance.
    d. Air is a solution.
    e. Elements occur only in the form of atoms.

    ANS: E          DIF: Easy          REF: 1.1
    OBJ: Distinguish between pure substances, mixtures, elements, and compounds.
    MSC: Conceptual

57. Which one of the following is *not* classified correctly?

    a. Distilled water is a compound.          d. Table salt (sodium chloride) is a mixture.
    b. Gold is an element.                     e. Tomato-basil pasta sauce is a food.
    c. Air is a solution.

    ANS: D          DIF: Easy          REF: 1.1
    OBJ: Distinguish between pure substances, mixtures, elements, and compounds.
    MSC: Conceptual

58. Which one of the following is *not* a chemical change?

    a. dynamite exploding          d. water turning to steam
    b. iron rusting                e. eggs cooking
    c. wood burning

    ANS: D          DIF: Easy          REF: 1.1
    OBJ: Define or recognize a chemical process.          MSC: Conceptual

59. Which one of the following statements is *not* correct?

    a. Dry ice subliming is a physical change.
    b. Methanol burning is a chemical change.
    c. Sugar dissolving in water is a physical change.
    d. Bleaching your hair is a chemical change, even though it changes your physical appearance.
    e. Liquid water turning into steam is a chemical change.

    ANS: E          DIF: Easy          REF: 1.1
    OBJ: Distinguish between a physical process and a chemical process.
    MSC: Conceptual

60. Air is an example of _____

    a. an element.                  d. a heterogeneous mixture.
    b. a compound.                  e. a homogeneous mixture.
    c. a pure substance.

    ANS: E          DIF: Easy          REF: 1.1
    OBJ: Distinguish between pure substances, mixtures, elements, and compounds.
    MSC: Conceptual

61. Which one of the following is *not* a correct statement?

    a. Vodka is a solution.
    b. Water ($H_2O$) is a compound.
    c. Sodium chloride (table salt) is a compound.
    d. Silver is an element.

e.   Sugar dissolved in water is a heterogeneous mixture.

ANS: E          DIF: Easy          REF: 1.1
OBJ: Distinguish between pure substances, mixtures, elements, and compounds.
MSC: Conceptual

62. Which one of the following statements is *not* correct?

a.   Sodium and chlorine are elements.
b.   Sodium chloride (table salt) is a compound.
c.   Sodium chloride is a pure substance.
d.   Sodium chloride is a heterogeneous mixture.
e.   Sodium chloride added to water forms a solution.

ANS: D          DIF: Easy          REF: 1.1
OBJ: Distinguish between pure substances, mixtures, elements, and compounds.
MSC: Conceptual

63. How thick is a piece of aluminum foil that measures 5 cm on each side and has a mass of 675 mg? The density of aluminum is 2.70 $g/cm^3$.

a.   1.0 mm                    d.   10 $\mu$m
b.   0.1 mm                    e.   1.0 $\mu$m
c.   0.01 mm

ANS: B          DIF: Medium          REF: 1.4
OBJ: Use density correctly in analysis and calculations.          MSC: Applied

64. Which one of the following is *not* a physical property?

a.   flammability              d.   density
b.   electrical conductivity   e.   boiling point
c.   color

ANS: A          DIF: Easy          REF: 1.4
OBJ: Distinguish between physical and chemical properties.          MSC: Conceptual

65. In the movie *The Italian Job*, thieves steal gold bullion. One plan was to carry the ingots of gold off in suitcases. If each suitcase were 20 inches × 14 inches × 10 inches, approximately how much would each suitcase weigh when filled with gold? The volume of the suitcase is $4.4 \times 10^4$ mL, the molar mass of gold is 197 g/mol, and the density of gold is 19.3 g/mL.

a.   2,300 g                   d.   167 mg
b.   850 kg                    e.   550 kg
c.   4,300 g

ANS: B          DIF: Medium          REF: 1.4
OBJ: Use density correctly in analysis and calculations.          MSC: Applied

66. The bubbles that form in water after it has been boiling for some time are _____

a.   empty space.             d.   filled with air.
b.   $H_2(g)$ and $O_2(g)$ gases.   e.   superhot water, $H_2O(\ell)$.
c.   the vapor phase of water, $H_2O(g)$.

ANS: C          DIF: Medium          REF: 1.6
OBJ: Identify the processes that accompany phase transitions.          MSC: Conceptual

67. The symbol and name corresponding to the factor $10^{-6}$ is

a.   f, femto                  d.   $\mu$, micro
b.   p, pico                   e.   m, milli
c.   n, nano

ANS: D    DIF: Easy    REF: 1.8
OBJ: Correctly use prefixes with SI base units.    MSC: Factual

68. The symbol and name corresponding to the factor $10^{-9}$ is

a. f, femto
b. p, pico
c. n, nano

d. $\mu$, micro
e. m, milli

ANS: C    DIF: Easy    REF: 1.8
OBJ: Correctly use prefixes with SI base units.    MSC: Factual

69. What would you report for the total mass of three samples weighing 106.2 g, 33.15 g, and 0.028 g?

a. 139 g
b. 139.3 g
c. 139.4 g

d. 139.38 g
e. 139.378 g

ANS: C    DIF: Easy    REF: 1.8
OBJ: Report results of addition and subtraction calculations to the correct number of significant figures.
MSC: Applied

70. You are a technician in an analytical laboratory and are asked to determine whether an antique coin might be gold from its density. You weigh the coin and find that its mass is 84.6419 g. When you placed the coin in a graduated cylinder containing 105.53 mL of water, the water level rose to 114.64 mL. Calculate the density of the coin from your measurements, and determine how many significant figures should be included in the reported result. Which one of the following numbers will you put in your report for the density of the coin?

a. 9.29 g/mL
b. 9.3 g/mL
c. 0.73833 g/mL

d. 9.2911 g/ml
e. 9.29109769 g/mL

ANS: A    DIF: Difficult    REF: 1.8
OBJ: Report the result of mixed arithmetic calculations to the correct number of significant figures.
MSC: Applied

71. If the following arithmetic operations were carried out, how many significant figures should the answer be reported to?

$5.70 \times 16.90 / 7.2356$

a. 1
b. 2
c. 3

d. 4
e. 5

ANS: C    DIF: Easy    REF: 1.8
OBJ: Report results of multiplication and division calculations to the correct number of significant figures.
MSC: Applied

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

$132.0 + 0.56 + 0.01 + 3.33$

a. 1
b. 2
c. 3

d. 4
e. 5

ANS: D    DIF: Easy    REF: 1.8
OBJ: Report results of addition and subtraction calculations to the correct number of significant figures.
MSC: Applied

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

a. $10^6 \ cm^3$

d. $10^6 \ mL$

b. $10^3$ L                                                      e. $100$ cm$^3$
c. $10^9$ mm$^3$

ANS: E      DIF: Medium      REF: 1.9
OBJ: Correctly convert between units using conversion factors.      MSC: Applied

74. This problem is from a *New York Times* article. Researchers tested a group of 28 doctors. The doctors were told that a five-year-old child suffering a potentially fatal allergic reaction to peanuts needed an emergency injection of 0.12 mg of epinephrine. The bottle of epinephrine is labeled 1 mg in 1 mL of solution. What volume of this solution would you inject if you were the doctor?

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

ANS: A      DIF: Difficult      REF: 1.9
OBJ: Correctly convert between units using conversion factors.      MSC: Applied

75. How many carbon atoms does it take to produce a layer one atom deep that is the size of the period at the end of the next sentence? Assume the area covered by the period is 0.2 mm$^2$ and that one carbon atom has a diameter of 160 pm and covers an area of 0.02 nm$^2$.

a. $1.0 \times 10^{12}$                                     d. $1.0 \times 10^{13}$
b. $1.0 \times 10^{11}$                                     e. $2.0 \times 10^{6}$
c. $1.0 \times 10^{7}$

ANS: D      DIF: Medium      REF: 1.9
OBJ: Correctly convert between units using conversion factors.      MSC: Applied

76. If an atom is 0.1 nm in diameter, how many atoms must be lined up to make a row 1 cm long?

a. $10^4$                                                   d. $10^{10}$
b. $10^6$                                                   e. $10^{12}$
c. $10^8$

ANS: C      DIF: Medium      REF: 1.9
OBJ: Correctly convert between units using conversion factors.      MSC: Applied

77. Determine the number of atoms across the diameter of a human hair given that the diameter of an atom is 0.1 nm and the diameter of a human hair is 0.1 mm.

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

ANS: D      DIF: Medium      REF: 1.9
OBJ: Correctly convert between units using conversion factors.      MSC: Applied

78. Determine the maximum number of atoms that could comprise a baseball given that the volume of a baseball is 200 cm$^3$ and the volume of an atom is 0.004 nm$^3$.

a. $5 \times 10^5$                                          d. $6.0 \times 10^{23}$
b. $5 \times 10^{25}$                                       e. $6.0 \times 10^{37}$
c. $5 \times 10^{17}$

ANS: B      DIF: Difficult      REF: 1.9
OBJ: Correctly convert between units using conversion factors.      MSC: Applied