Chapter 1: Matter and Energy: The Origin 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: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

2. A pure substance _____
   a. can not 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: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

3. An element _____
   a. can be separated into its components by physical methods.
   b. may have different chemical properties depending on its source.
   c. can not 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: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

4. 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: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

5. Which of the following is a pure substance?
   a. mineral water
   b. blood
   c. brass (an alloy of copper and zinc)
   d. sucrose (table sugar)
   e. beer

   ANS: D DIF: Easy REF: 1.1
   OBJ: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

6. Which of the following is an element?

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

ANS: A DIF: Easy REF: 1.1
OBJ: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

7. Which of the following is a homogeneous mixture?
a. filtered water
b. chicken noodle soup
c. clouds
d. trail mix snack
e. fruit salad

ANS: A DIF: Easy REF: 1.1
OBJ: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

8. Which of the following is a heterogeneous mixture?
a. air
b. sugar dissolved in water
c. muddy river water
d. brass (an alloy of copper and zinc)
e. table salt (sodium chloride)

ANS: C DIF: Easy REF: 1.1
OBJ: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

9. 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: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

10. Air is an example of _____
a. an element.
b. a compound.
c. a pure substance.
d. a heterogeneous mixture.
e. a homogeneous mixture.

ANS: E DIF: Easy REF: 1.1
OBJ: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

11. 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: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

12. Which one of the following is *not* classified correctly?
    a. Distilled water is a compound.
    b. Gold is an element.
    c. Air is a solution.
    d. Table salt (sodium chloride) is a mixture.
    e. Salad dressing is a suspension.

    ANS: D DIF: Easy REF: 1.1
    OBJ: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

13. 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 individual atoms.

    ANS: E DIF: Medium REF: 1.1
    OBJ: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

14. Which one of the following statements is *not* correct?
    a. A compound has a specific constant composition.
    b. The composition of a mixture can vary.
    c. A compound has specific constant properties.
    d. The properties of a mixture can vary.
    e. Mixtures can not be homogeneous.

    ANS: E DIF: Easy REF: 1.1
    OBJ: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. KEY: 2014
    MSC: Understanding

15. Identify the *incorrect* statement(s). A solution _____
    I. can be a solid, liquid, or gas.
    II. can be heterogeneous or homogeneous.
    III. is a homogeneous mixture.
    a. Only I is incorrect.
    b. Only II is incorrect.
    c. Only III is incorrect.
    d. Both I and II are incorrect.
    e. Both I and III are incorrect.

    ANS: B DIF: Easy REF: 1.1
    OBJ: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. KEY: 2014
    MSC: Understanding

16. Identify the *incorrect* statement(s). A pure substance can be _____
    I. an element or a compound.
    II. heterogeneous or homogeneous.
    III. a solution.
    a. Only I is incorrect.
    b. Only II is incorrect.
    c. Only III is incorrect.
    d. Both I and II are incorrect.
    e. Both II and III are incorrect.

ANS: E DIF: Easy REF: 1.1
OBJ: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. KEY: 2014
MSC: Understanding

17. Table sugar (sucrose) with the formula $C_{12}H_{22}O_{11}$ is _____

I. an element.
II. a compound.
III. a mixture.

a. Only I
b. Only II
c. Only III
d. Both I and III
e. Both II and III

ANS: B DIF: Easy REF: 1.1
OBJ: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. KEY: 2014
MSC: Understanding

18. Which one of the following is *not* a chemical reaction?
a. dynamite exploding
b. iron rusting
c. wood burning
d. water turning to steam
e. eggs cooking

ANS: D DIF: Easy REF: 1.1
OBJ: Distinguish between a physical process and a chemical reaction: define, give examples of, and recognize each. MSC: Understanding

19. Which one of the following statements is *not* correct?
a. Dry ice subliming is a physical change.
b. Methanol burning is a chemical reaction.
c. Sugar dissolving in water is a physical change.
d. Bleaching your hair is a chemical change (reaction), even though it changes your physical appearance.
e. Liquid water turning into steam is a chemical reaction.

ANS: E DIF: Easy REF: 1.1
OBJ: Distinguish between a physical process and a chemical reaction: define, give examples of, and recognize each. MSC: Understanding

20. Which one of the following is *not* a physical process or change?
a. natural gas burning
b. water boiling
c. ice melting
d. iodine vaporizing
e. alcohol evaporating

ANS: A DIF: Easy REF: 1.1
OBJ: Distinguish between a physical process and a chemical reaction: define, give examples of, and recognize each. KEY: 2014 MSC: Understanding

21. Which of the following processes is a chemical reaction?
a. distillation
b. combustion
c. filtration
d. condensation
e. sublimation

ANS: B DIF: Easy REF: 1.1
OBJ: Distinguish between a physical process and a chemical reaction: define, give examples of, and

recognize each. KEY: 2014 MSC: Understanding

22. The law of constant composition states that _____
    a. compounds such as NO_2 and SO_2 have identical chemical properties.
    b. the elements forming a particular compound always combine in the same proportions.
    c. nitrogen and oxygen can combine to form NO or NO_2.
    d. compounds such as NO and NO_2 have identical chemical properties.
    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: Remembering

23. 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 chemical formula (a.k.a. molecular formula) and a structural formula. MSC: Remembering

24. Molecules are represented in various ways. Which statement A–D about molecular representations is *not* correct.
    a. A molecular or chemical formula identifies the elements and the number of atoms of each that comprise a molecule of a compound.
    b. A structural formula shows how the atoms are bonded together but does not necessarily indicate the bond angles or three-dimensional shape of the molecule.
    c. A ball-and-stick model shows bond angles and the three-dimensional shape of a molecule.
    d. A space-filling model best represents the size of the atoms and distribution of electrons in a molecule.
    e. Statements A–D all are correct.

    ANS: E DIF: Easy REF: 1.2
    OBJ: Describe the information provided by a chemical formula (a.k.a. molecular formula) and a structural formula. KEY: 2014 MSC: Remembering

25. Which statement A–D about the reaction of methane with oxygen, which is called combustion and is represented by the reaction equation below, is *not* correct? The reaction products are carbon dioxide and water.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

    a. One molecule of methane combines with two molecules of oxygen.
    b. The products are one molecule of carbon dioxide and two molecules of water.
    c. The equation is balanced because the number of atoms of each element does not change.
    d. Four atoms of hydrogen combine with four atoms of oxygen to produce water.
    e. Statements A–D all are correct.

    ANS: D DIF: Easy REF: 1.2
    OBJ: Describe what occurs in a chemical reaction and the information provided by a chemical reaction equation. KEY: 2014 MSC: Understanding

26. Filtration can be used to separate components in a mixture based on differences in _____

a. solubility.
b. boiling point.
c. melting point.
d. particle size.
e. color.

ANS: D DIF: Easy REF: 1.3
OBJ: Describe the process of filtration. KEY: 2014 MSC: Remembering

27. Distillation may be used to separate components in a mixture based on differences in _____
a. solubilities.
b. boiling points.
c. melting points.
d. masses.
e. color.

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

28. Which of the following mixtures can be separated by filtration?
a. sugar dissolved in coffee
b. sand and water
c. gasoline
d. alcohol dissolved in water
e. air

ANS: B DIF: Easy REF: 1.3
OBJ: Identify when filtration and distillation can be used. MSC: Understanding

29. 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: 1.5
OBJ: Distinguish between physical and chemical properties: define and give examples of each.
MSC: Understanding

30. 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: 1.5
OBJ: Distinguish between physical and chemical properties: define and give examples of each.
MSC: Understanding

31. Which one of the following is *not* a physical property?
a. flammability
b. electrical conductivity
c. color
d. density
e. boiling point

ANS: A DIF: Easy REF: 1.5
OBJ: Distinguish between physical and chemical properties: define and give examples of each.
MSC: Understanding

32. 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: 1.5
OBJ: Distinguish between physical and chemical properties: define and give examples of each.
MSC: Understanding

33. 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: 1.5
OBJ: Distinguish between physical and chemical properties: define and give examples of each.
MSC: Understanding

34. 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. 25 g/cm^3.

ANS: A DIF: Easy REF: 1.5
OBJ: Define density and use density correctly in analysis and calculations.
MSC: Applying

35. 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
b. 0.570 cm^3
c. 3.56×10^4 cm^3
d. 35.6 cm^3
e. 1.76 cm^3

ANS: A DIF: Easy REF: 1.5
OBJ: Define density and use density correctly in analysis and calculations.
MSC: Applying

36. 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: 1.5
OBJ: Define density and use density correctly in analysis and calculations.
MSC: Understanding

37. How thick is a square 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
b. 0.1 mm
c. 0.01 mm
d. 10 μm
e. 1.0 μm

ANS: B DIF: Medium REF: 1.5
OBJ: Define density and use density correctly in analysis and calculations.
MSC: Applying

38. Jupiter's mass is estimated to be 1.90×10^{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
    b. 1.61 g/cm^3
    c. 1.24 g/cm^3
    d. 0.00124 g/cm^3
    e. 1240 g/cm^3

    ANS: C DIF: Difficult REF: 1.5
    OBJ: Define density and use density correctly in analysis and calculations.
    MSC: Applying

39. 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 19 inches × 14 inches × 10 inches, approximately how much would each suitcase weigh when filled with gold? The volume of each suitcase is 4.4×10^4 mL, the molar mass of gold is 197 g/mol, and the density of gold is 19.3 g/mL.
    a. 2,300 g
    b. 850 kg
    c. 4,300 g
    d. 167 mg
    e. 550 kg

    ANS: B DIF: Difficult REF: 1.5
    OBJ: Define density and use density correctly in analysis and calculations.
    MSC: Applying

40. 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 24 inches × 18 inches × 12 inches, approximately how much would each suitcase weigh when filled with gold? The molar mass of gold is 197 g/mol, the density of gold is 19.3 g/cm^3, 1 in = 2.54 cm, and 1 kg = 2.20 lb.
    a. 3,600 lb
    b. 560 lb
    c. 2,200 lb
    d. 280 lb
    e. 1,800 lb

    ANS: A DIF: Difficult REF: 1.5
    OBJ: Define density and use density correctly in analysis and calculations.
    KEY: 2014 MSC: Applying

41. 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: 1.5
    OBJ: Define, give examples of, and distinguish between intensive and extensive properties.
    MSC: Understanding

42. 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: 1.5
    OBJ: Define, give examples of, and distinguish between intensive and extensive properties.
    MSC: Understanding

43. 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: Describe and distinguish between the three states of matter (solid, liquid, and gas) at the macroscopic and atomic levels. MSC: Remembering

44. A solid directly forming a vapor or gas is called _____.
    a. sublimation
    b. deposition
    c. melting
    d. freezing
    e. vaporization

    ANS: A DIF: Easy REF: 1.6
    OBJ: Describe and distinguish transitions (sublimation and deposition, melting and freezing,vaporization and condensation) between the three states of matter at the macroscopic and atomic levels. KEY: 2014 MSC: Remembering

45. A vapor or gas forming a solid is called _____.
    a. sublimation
    b. deposition
    c. melting
    d. freezing
    e. vaporization

    ANS: B DIF: Easy REF: 1.6
    OBJ: Describe and distinguish transitions (sublimation and deposition, melting and freezing,vaporization and condensation) between the three states of matter at the macroscopic and atomic levels. KEY: 2014 MSC: Remembering

46. A solid forming a liquid is called _____.
    a. sublimation
    b. deposition
    c. melting
    d. freezing
    e. vaporization

    ANS: C DIF: Easy REF: 1.6
    OBJ: Describe and distinguish transitions (sublimation and deposition, melting and freezing,vaporization and condensation) between the three states of matter at the macroscopic and atomic levels. KEY: 2014 MSC: Remembering

47. A liquid forming a solid is called _____.
    a. sublimation
    b. deposition
    c. melting
    d. freezing
    e. vaporization

    ANS: D DIF: Easy REF: 1.6
    OBJ: Describe and distinguish transitions (sublimation and deposition, melting and freezing,vaporization and condensation) between the three states of matter at the macroscopic and atomic levels. KEY: 2014 MSC: Remembering

48. A liquid forming a gas is called _____.
    a. sublimation
    b. deposition
    d. freezing
    e. vaporization

c. melting

ANS: E DIF: Easy REF: 1.6
OBJ: Describe and distinguish transitions (sublimation and deposition, melting and freezing,vaporization and condensation) between the three states of matter at the macroscopic and atomic levels. KEY: 2014 MSC: Remembering

49. A gas forming a liquid is called _____.
a. condensation
b. deposition
c. melting
d. freezing
e. vaporization

ANS: A DIF: Easy REF: 1.6
OBJ: Describe and distinguish transitions (sublimation and deposition, melting and freezing,vaporization and condensation) between the three states of matter at the macroscopic and atomic levels. KEY: 2014 MSC: Remembering

50. When you place a piece of dry ice (solid carbon dioxide) on a plate at room temperature, 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.
b. undergoes deposition instead of melting.
c. sublimes instead of melting.
d. does not exist in the liquid form at room temperature and pressure.
e. contains no water.

ANS: C DIF: Easy REF: 1.6
OBJ: Describe and distinguish transitions (sublimation and deposition, melting and freezing,vaporization and condensation) between the three states of matter at the macroscopic and atomic levels. MSC: Understanding

51. Deposition is the process in which a _____ is converted into a _____.
a. liquid; solid
b. gas; liquid
c. gas; solid
d. liquid; gas
e. solid; liquid

ANS: C DIF: Easy REF: 1.6
OBJ: Describe and distinguish transitions (sublimation and deposition, melting and freezing,vaporization and condensation) between the three states of matter at the macroscopic and atomic levels. MSC: Remembering

52. The bubbles that form in water after it has been boiling for some time are _____
a. empty space.
b. $H_2(g)$ and $O_2(g)$ gases.
c. the vapor phase of water, $H_2O(g)$.
d. filled with air.
e. superhot water, $H_2O(l)$.

ANS: C DIF: Medium REF: 1.6
OBJ: Describe and distinguish transitions (sublimation and deposition, melting and freezing,vaporization and condensation) between the three states of matter at the macroscopic and atomic levels. MSC: Understanding

53. A hypothesis is _____
a. an explanation that cannot be validated.
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: Define, give examples of, and distinguish between a hypothesis and a scientific theory.
MSC: Remembering

54. 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 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: Define, give examples of, and distinguish between a hypothesis and a scientific theory.
MSC: Remembering

55. 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: 1.8
OBJ: Name the SI units, their abbreviations, and the relevant quantities.
MSC: Remembering

56. Which of the following is *not* a base SI unit?
a. cm
b. m
c. kg
d. sec
e. mol

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

57. Which of the following is a derived SI unit?
a. m
b. kg
c. cm^3
d. m^3
e. lb

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

58. Which of the following is the most massive?
a. 2.5 kg of oxygen gas
b. 0.25 kg of iron
c. 2.5 g of sodium chloride (table salt)
d. 250 g of helium gas
e. 250 mg of aluminum

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

59. The symbol and name corresponding to the factor 10^{-6} is
a. f, femto
b. p, pico
d. μ, micro
e. m, milli

c. n, nano

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

60. The symbol and name corresponding to the factor 10^{-9} is
a. f, femto
b. p, pico
c. n, nano
d. μ, micro
e. m, milli

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

61. Medicines usually are dispensed in units of mg. What is the mass of a 50 mg tablet?
a. 50 grams
b. 5.0 grams
c. 0.50 grams
d. 0.050 grams
e. 0.0050 grams

ANS: D DIF: Easy REF: 1.8
OBJ: Correctly use prefixes with SI base units. KEY: 2014
MSC: Remembering

62. How many 100 mg tablets can be produced from 100 kg of a pharmaceutical product?
a. 1,000
b. 10,000
c. 100,000
d. 1,000,000
e. 10,000,000

ANS: D DIF: Easy REF: 1.8
OBJ: Correctly use prefixes with SI base units. KEY: 2014
MSC: Applying

63. The diameter of the sun is 1,390,000 km. In scientific notation this is
a. 1.39×10^{-6} km
b. 1.39×10^{-3} km
c. 1.39×10^{6} km
d. 1.39×10^{3} km
e. 1.39×10^{8} m

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

64. Electromagnetic radiation in the mid-infrared region of the spectrum has wavelengths around 0.6 μm. Express this wavelength in meters using exponential notation (1 μm = 10^{-6} m).
a. 1.06×10^{-6} m
b. 1.06×10^{-5} m
c. 1.06 m
d. 1.06×10^{7} m
e. 1.06×10^{5} m

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

65. Which of the following quantities has two significant figures?
a. 0.4
b. 101
c. 1.10×10^{3}
d. 0.0092
e. 0.520

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

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

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

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

67. Which one of the following values A–D contains four significant figures? If all do, choose E.

a. 0.0004 kg
b. 0.0040 L
c. 0.0400 m
d. 0.4000 mm
e. All contain four significant figures.

ANS: D DIF: Easy REF: 1.8
OBJ: Identify the number of significant figures in a measurement.
KEY: 2014 MSC: Applying

68. You measure and find that an object has a mass of 25.15 g and a volume of 9.3 cm^3. What would you report as the density of the object?

a. 2.704 g/cm^3
b. 2.70 g/cm^3
c. 2.7 g/cm^3
d. 3 g/cm^3
e. 2.704301075 g/cm^3

ANS: C DIF: Easy REF: 1.8
OBJ: Express values obtained from measurement and calculation using the appropriate number of significant figures. MSC: Applying

69. You are a technician in an analytical laboratory and are asked to determine from its density whether an antique coin might be gold. You weigh the coin and find that its mass is 84.6419 g. When you place the coin in a graduated cylinder containing 105.53 mL of water, the water level rises 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: Express values obtained from measurement and calculation using the appropriate number of significant figures. MSC: Applying

70. 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: Express values obtained from measurement and calculation using the appropriate number of significant figures. MSC: Applying

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

$(5.70 \times 16.90) / 7.2356$

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

ANS: C DIF: Easy REF: 1.8
OBJ: Express values obtained from measurement and calculation using the appropriate number of significant figures. MSC: Applying

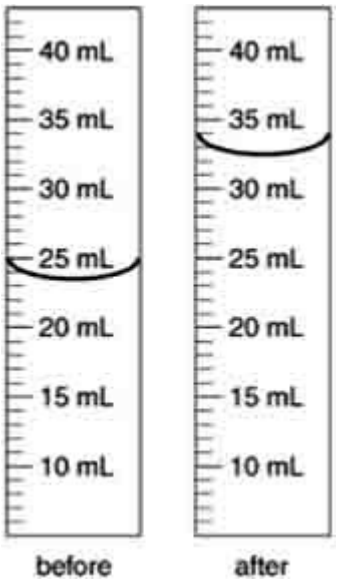
72. If the following arithmetic operations are carried out, how many significant figures should be reported in the answer?

$132.0 + 0.56 + 0.01 + 3.33$

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

ANS: D DIF: Easy REF: 1.8
OBJ: Express values obtained from measurement and calculation using the appropriate number of significant figures. MSC: Applying

73. 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. 2.8 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: Easy REF: 1.8
OBJ: Express values obtained from measurement and calculation using the appropriate number of significant figures. MSC: Applying

74. A burette (shown below) was used to add dilute hydrochloric acid (HCl) to a solution containing sodium hydroxide (NaOH). If the burette 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. 4.3 mL
e. 4.30 mL

ANS: C DIF: Difficult REF: 1.8
OBJ: Express values obtained from measurement and calculation using the appropriate number of significant figures. MSC: Applying

75. Which statement A–D about *accuracy* and *precision* is *not* correct?
a. *Precision* refers to the reproducibility of repeated measurements.
b. *Accuracy* refers to how close a measured value is to the true value.
c. It is possible for measurements to be precise but not accurate.
d. Accuracy is determined by comparison with some standard.
e. Statements A–D all are correct.

ANS: E DIF: Easy REF: 1.8
OBJ: Write definitions of precision and accuracy. KEY: 2014
MSC: Remembering

76. 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
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, 1.510 g, 1.523 g

ANS: D DIF: Easy REF: 1.8
OBJ: Identify precision and accuracy in measurements and distinguish between them.
MSC: Applying

77. 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 precision and accuracy in measurements and distinguish between them.
MSC: Applying

78. 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 pipette (with a to-deliver error of 0.01 mL at 25°C)

ANS: E DIF: Easy REF: 1.8
OBJ: Identify precision and accuracy in measurements and distinguish between them.
MSC: Applying

79. 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.
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: A DIF: Medium REF: 1.8
OBJ: Identify precision and accuracy in measurements and distinguish between them.
MSC: Understanding

80. 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.
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: Medium REF: 1.8
OBJ: Identify precision and accuracy in measurements and distinguish between them.
MSC: Understanding

81. The following measurements of the mass of an aspirin tablet were made by different students in a lab. Each set gives the results of 3 measurements followed by the average. Which set is the most precise? All values are in grams. The standard value reported by an analytical laboratory was 1.501 *g*.
a. 1.513, 1.503, 1.522 = 1.513
b. 1.513, 1.511, 1.450 = 1.491
c. 1.513, 1.459, 1.533 = 1.502
d. 1.513, 1.517, 1.512 = 1.514
e. 1.513, 1.510, 1.523 = 1.515

ANS: D DIF: Easy REF: 1.8
OBJ: Identify precision and accuracy in measurements and distinguish between them.
KEY: 2014 MSC: Applying

82. The following measurements of the mass of an aspirin tablet were made by different students in a lab. Each set gives the results of 3 measurements followed by the average. Which set produced the most accurate result? All values are in grams. The standard value reported by an analytical laboratory was 1.501 g.
a. 1.513, 1.503, 1.522 = 1.513
b. 1.513, 1.511, 1.450 = 1.491
c. 1.513, 1.459, 1.533 = 1.502
d. 1.513, 1.517, 1.512 = 1.514
e. 1.513, 1.510, 1.523 = 1.515

ANS: C DIF: Easy REF: 1.8
OBJ: Identify precision and accuracy in measurements and distinguish between them.
MSC: Applying

83. The summit of Mt. Humphreys, the highest point in Arizona, is 12,600 ft. How many meters is this? (1 m = 1.0936 yd, 1 yd = 3 ft exactly)
a. 4,593 m
b. 3,841 m
c. 34,565 m
d. 41,338 m
e. 37,800 m

ANS: B DIF: Easy REF: 1.9
OBJ: Convert between units using conversion factors. MSC: Applying

84. Which one of the following is *not* equal to exactly one 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 dm^3

ANS: E DIF: Medium REF: 1.9
OBJ: Convert between units using conversion factors. MSC: Applying

85. In 1 second, light can travel 2.998×10^8 m. How many inches does light travel in 1 femtosecond (1 fs = 10^{-15} s, 1 inch = 2.54 cm exactly)?
a. 1180 in
b. 11.80 in
c. 1.180 in
d. 1.180×10^{-5} in
e. 1.180×10^{-7} in

ANS: D DIF: Easy REF: 1.9
OBJ: Apply dimensional analysis (a.k.a. unit analysis) to guide and validate calculations.
MSC: Applying

86. 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
b. 0.10 s
c. 56 s
d. 18 s
e. 0.43 s

ANS: A DIF: Medium REF: 1.9
OBJ: Apply dimensional analysis (a.k.a. unit analysis) to guide and validate calculations.
MSC: Applying

87. Spanish mahogany has a density of 53 lb/ft^3. 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: Apply dimensional analysis (a.k.a. unit analysis) to guide and validate calculations.
MSC: Applying

88. 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. 1.0×10^{12}
b. 1.0×10^{11}
c. 1.0×10^{7}
d. 1.0×10^{13}
e. 2.0×10^{6}

ANS: D DIF: Medium REF: 1.9
OBJ: Apply dimensional analysis (a.k.a. unit analysis) to guide and validate calculations.
MSC: Applying

89. 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}
b. 10^{6}
c. 10^{8}
d. 10^{10}
e. 10^{12}

ANS: C DIF: Medium REF: 1.9
OBJ: Apply dimensional analysis (a.k.a. unit analysis) to guide and validate calculations.
MSC: Applying

90. 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}
b. 10^{12}
c. 10^{3}
d. 10^{6}
e. 10^{9}

ANS: D DIF: Medium REF: 1.9
OBJ: Apply dimensional analysis (a.k.a. unit analysis) to guide and validate calculations.
MSC: Applying

91. 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. 5×10^{5}
b. 5×10^{25}
c. 5×10^{17}
d. 6.0×10^{23}
e. 6.0×10^{37}

ANS: B DIF: Difficult REF: 1.9
OBJ: Apply dimensional analysis (a.k.a. unit analysis) to guide and validate calculations.
MSC: Applying

92. The density of quartz is 165 lb/ft^3. A clear crystal with a mass of 26.5 g is found to displace 10.0 cm^3 of water. The crystal has a density _____
a. of 2.65 g/cm^3 and therefore is most likely quartz.
b. of 2.65 g/cm^3 and therefore is not quartz.
c. of 2.75 g/cm^3 and might be quartz. Better measurements are needed for a definitive test.
d. of 2.55 g/cm^3. Better measurements are needed for a definitive test.
e. very different from that of quartz.

ANS: A DIF: Difficult REF: 1.9
OBJ: Apply dimensional analysis (a.k.a. unit analysis) to guide and validate calculations.
MSC: Applying

93. This problem is from a *New York Times* article. Researchers tested a group of 28 doctors. The doctors were told that a 5-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
b. 120 mL
c. 1.2×10^{-4} mL
d. 12 mL
e. 1.2 mL

ANS: A DIF: Difficult REF: 1.9
OBJ: Apply dimensional analysis (a.k.a. unit analysis) to guide and validate calculations.
MSC: Applying

94. Usain Bolt holds the world record for the 100 m dash at 9.58 s. What was his average speed in miles/hour for this distance? The equivalence statements are 1 km = 0.621 mi and 3,600 s = 1 hr. It is interesting to compare this value with the average speed for walking (3 mph), bicycling (12 mph), and horse racing (38 mph).
a. 23.3 mi/hr
b. 46.6 mi/hr
c. 11.7 mi/hr
d. 18.7 mi/hr
e. 26.7 mi/hr

ANS: A DIF: Easy REF: 1.9
OBJ: Apply dimensional analysis (a.k.a. unit analysis) to guide and validate calculations.
KEY: 2014 MSC: Applying

95. 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: 1.1
OBJ: Convert between temperature scales: Kelvin, Celsius, and Fahrenheit.
MSC: Understanding

96. Room temperature is often taken to be 25°C. What is this temperature in °F?
a. 46°F
d. 77°F

b. 45°F
c. 14°F
e. 72°F

ANS: D DIF: Easy REF: 1.1
OBJ: Convert between temperature scales: Kelvin, Celsius, and Fahrenheit.
MSC: Applying

97. On a summer day, the temperature in Phoenix, Arizona, was recorded as 110°F. What is this temperature in °C?
a. 43°C
b. 78°C
c. 166°C
d. 93°C
e. 29°C

ANS: A DIF: Easy REF: 1.1
OBJ: Convert between temperature scales: Kelvin, Celsius, and Fahrenheit.
MSC: Applying

98. The temperature of the surface of the sun is 5800 K. What is this in °F?
a. 5495°F
b. 5527°F
c. 9981°F
d. 3103°F
e. 10,900°F

ANS: C DIF: Easy REF: 1.1
OBJ: Convert between temperature scales: Kelvin, Celsius, and Fahrenheit.
MSC: Applying

99. 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: 1.1
OBJ: Convert between temperature scales: Kelvin, Celsius, and Fahrenheit.
MSC: Applying

100. 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: 1.1
OBJ: Convert between temperature scales: Kelvin, Celsius, and Fahrenheit.
MSC: Applying