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: 1.2
   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: 1.2
   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. cannot be separated into simpler substances by chemical methods.
   d. can also be a compound.
   e. exists only as an atom and not as a molecule.

   ANS: C DIF: Easy REF: 1.2
   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: 1.2
   OBJ: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

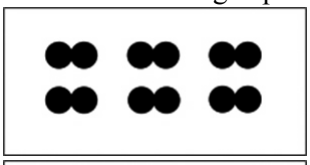
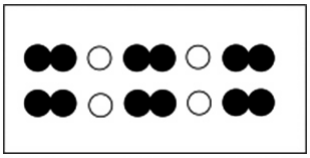
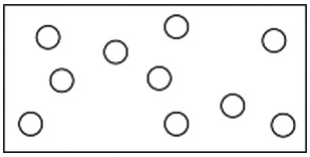
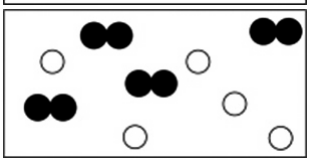
5. Which of the following is a pure substance?
   a. mineral water
   b. blood
   c. brass (an alloy of copper and zinc)
   d. sucrose (table sugar)
   e. beer

   ANS: D DIF: Easy REF: 1.2
   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: 1.2
OBJ: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

7. Which of the following depicts a heterogeneous mixture?
a. 
b. 
c. 
d. 
e. None of the above are heterogeneous mixtures.

ANS: D DIF: Easy REF: 1.2
OBJ: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

8. Which of the following is *not* a homogeneous mixture?
a. vinegar
b. Italian salad dressing
c. a can of soda
d. antifreeze
e. ketchup

ANS: B DIF: Easy REF: 1.2
OBJ: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

9. 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: 1.2
OBJ: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

10. 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: 1.2
OBJ: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

11. A heterogeneous mixture _____
a. can only be separated into its components by chemical methods.
b. involves substances solely in the gas phase.
c. has non-uniform sample composition.
d. exclusively refers to substances in the same phase.
e. is also called a solution.

ANS: C DIF: Easy REF: 1.2
OBJ: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

12. Orange juice with pulp is an example of _____
a. a pure substance.
b. a heterogeneous mixture.
c. a compound.
d. an element.
e. a homogeneous mixture.

ANS: B DIF: Easy REF: 1.2
OBJ: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

13. 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: 1.2
OBJ: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

14. 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: 1.2
OBJ: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

15. 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: 1.2
OBJ: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

16. 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: 1.2
OBJ: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

17. 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: 1.2
OBJ: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

18. 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: 1.2
OBJ: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

19. 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: 1.2
OBJ: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

20. Which one of the following is *not* a chemical reaction?
    a. dynamite exploding
    d. water turning to steam

b. iron rusting
c. wood burning
e. eggs cooking

ANS: D DIF: Easy REF: 1.2
OBJ: Distinguish between a physical process and a chemical reaction: define, give examples of, and recognize each. MSC: Understanding

21. 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: 1.2
OBJ: Distinguish between a physical process and a chemical reaction: define, give examples of, and recognize each. MSC: Understanding

22. 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: 1.2
OBJ: Distinguish between a physical process and a chemical reaction: define, give examples of, and recognize each. MSC: Understanding

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

ANS: B DIF: Easy REF: 1.2
OBJ: Distinguish between a physical process and a chemical reaction: define, give examples of, and recognize each. MSC: Understanding

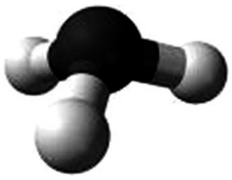
24. The law of constant composition states that _____
a. compounds such as NO_2 and SO_2 have identical chemical properties.
b. the elements forming a particular compound always combine in the same proportions.
c. nitrogen and oxygen can combine to form NO or NO_2.
d. compounds such as NO and NO_2 have identical chemical properties.
e. only one compound can be produced when two elements combine.

ANS: B DIF: Easy REF: 1.2
OBJ: Describe how a compound is an example of the law of constant composition.
MSC: Remembering

25. Atoms are to molecules as _____
a. a country to a state or province.
b. soda is to orange juice.
c. cars are to trucks.
d. a washer is to a dryer.
e. letters are to words.

ANS: E DIF: Medium REF: 1.2
OBJ: Describe different forms of matter: distinguish between pure substances, solutions, heterogeneous mixtures, elements, and compounds. MSC: Understanding

26. The following representation of ammonia is a _____



a. space-filling model.
b. structural formula.
c. chemical formula.
d. ball-and-stick model.
e. Newman projection.

ANS: D DIF: Easy REF: 1.2
OBJ: Describe the information provided by chemical formula, structural formula, ball-and-stick models, and space-filling models. MSC: Remembering

27. 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 chemical formula, structural formula, ball-and-stick models, and space-filling models. MSC: Remembering

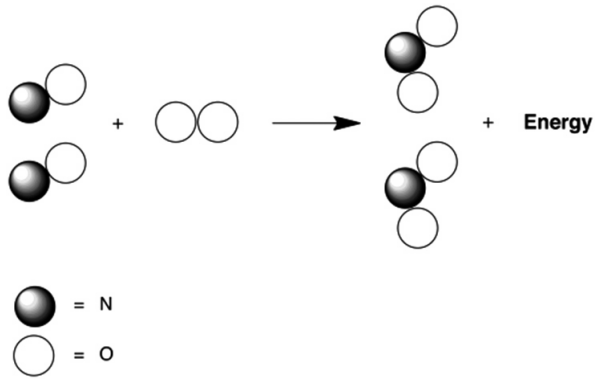
28. Which statement A–D about the reaction of methane with oxygen, which is called combustion and is represented by the reaction equation below, is *not* correct? The reaction products are carbon dioxide and water.

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

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. MSC: Understanding

29. Which statement A–D about the reaction of nitrogen monoxide with oxygen, which is called combustion and is represented below by the following cartoon, is *not* correct? The reaction product is nitrogen dioxide.



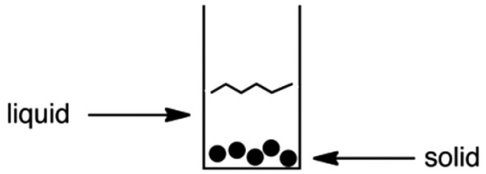
a. Two molecules of nitrogen monoxide combine with one molecule of oxygen.
b. Two atoms of nitrogen combine with four atoms of oxygen to produce two molecules of nitrogen dioxide.
c. The equation is balanced because the number of atoms of each element does not change.
d. The products are two molecules of nitrogen dioxide and released energy.
e. Statements A–D all are correct.

ANS: B DIF: Easy REF: 1.2
OBJ: Describe what occurs in a chemical reaction and the information provided by a balanced chemical reaction. MSC: Understanding

30. 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. MSC: Remembering

31. Which technique would allow separation of the following substances?



a. distillation
b. extraction
c. filtration
d. recrystallization
e. chromatography

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

32. A significant difference in boiling points of two liquids could provide the basis for separation by what physical method?
a. distillation
b. extraction
c. filtration
d. recrystalization
e. chromatography

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

33. Which of the following mixtures can be separated by filtration?
a. sugar dissolved in coffee
d. alcohol dissolved in water

b. sand and water
c. gasoline
e. air

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

34. 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

35. 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

36. 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

37. Which of the following *does not* represent a physical property of caffeine?
a. Caffeine melts at 238°C.
b. Caffeine dissolves in water.
c. Caffeine has a density of 1.23 g/mL.
d. In the body, caffeine reacts with adenosine receptors in the central nervous system.
e. Caffeine is a white powder.

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

38. Which of the following is *not* a chemical property of chlorine?
a. reduction by water to form HCl and dioxygen
b. decomposition to yield two chlorine radicals upon heating
c. freezing at −102°C
d. reaction with methane produces chloromethane
e. conversion to sodium chloride by addition of sodium metal

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

39. A metal object that has a density of 5.2 g/cm^3 occupies a volume of 3.7 cm^3. What is the mass of the object?

a. 1.4 g
b. 19 g
c. 0.71 g
d. 8.9 g
e. 3.7 g

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

40. 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

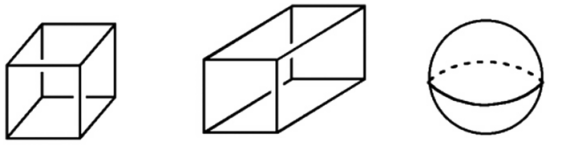
ANS: A DIF: Easy REF: 1.5
OBJ: Define density and use density correctly in analysis and calculations.
MSC: Applying

41. 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

42. Three metals, and their densities, are shown below. If each were added to the same volume of water (density = 1.00 cm^3), which metal(s) would sink?



Metal 1 d = 1.34 g/cm^3 Metal 2 d = 0.69 g/cm^3 Metal 3 d = 3.64 g/cm^3

a. 1 only
b. 2 only
c. 3 only
d. 1 and 2 only
e. 1 and 3 only

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

43. 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

44. In the movie *The Italian Job*, thieves steal gold bullion. One plan is 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

45. _____ is an example of an extensive property.
a. Density
b. Boiling point
c. Color
d. Volume
e. Malleability

ANS: D DIF: Easy REF: 1.5
OBJ: Define, give examples of, and distinguish between intensive and extensive properties.
MSC: Understanding

46. 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

47. 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

48. Which of the following statements correctly describes the properties of a liquid?
a. A liquid does not have a definite shape.
b. A liquid occupies the entire volume of its container.
c. A liquid is highly compressible.
d. A liquid contains molecules that are separated from one another by large distances.
e. A liquid is highly ordered, such that molecules remain rigidly in place.

ANS: A 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

49. 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. MSC: Remembering

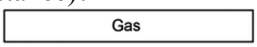
50. A vapor or gas forming a solid is called _____
    a. sublimation.
    b. deposition.
    c. melting.
    d. freezing.
    e. vaporization.

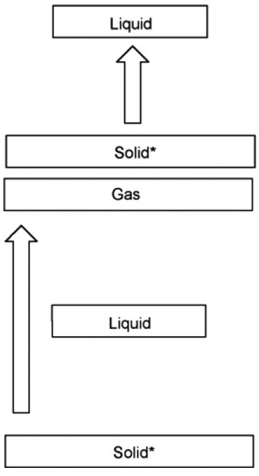
    ANS: B DIF: Easy REF: 1.6
    OBJ: Describe and distinguish transitions (sublimation and deposition, melting and freezing, vaporization and condensation) between the three states of matter at the macroscopic and atomic levels. MSC: Remembering

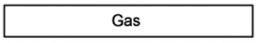
51. A solid forming a liquid is called _____
    a. sublimation.
    b. deposition.
    c. melting.
    d. freezing.
    e. vaporization.

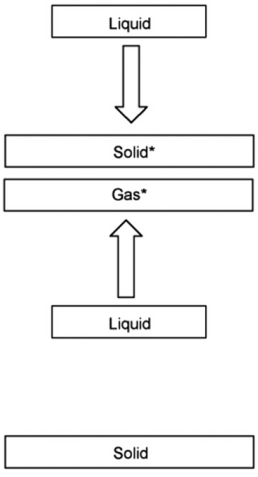
    ANS: C DIF: Easy REF: 1.6
    OBJ: Describe and distinguish transitions (sublimation and deposition, melting and freezing, vaporization and condensation) between the three states of matter at the macroscopic and atomic levels. MSC: Remembering

52. Which diagram depicts the process of sublimation (an asterisk denotes the initial phase of the substance)?

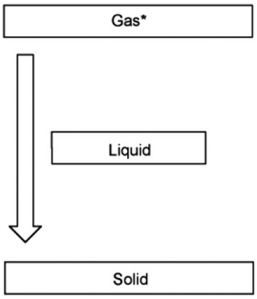
    a. 

    b. 

    d. 

    e. 

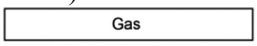
c.



ANS: B 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: Remembering

53. Which diagram shown below represents condensation (an asterisk denotes the initial phase of the substance)?

a.



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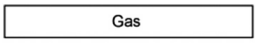
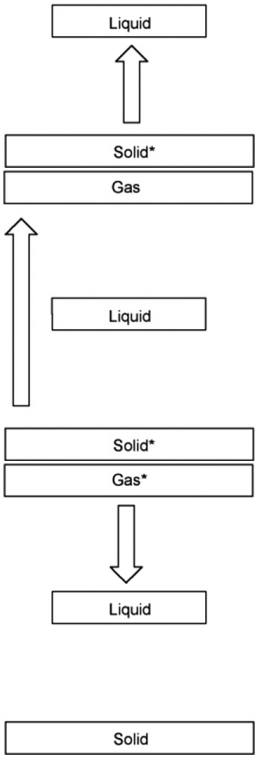
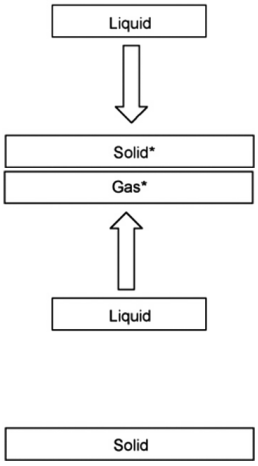


b.



e.



c.

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: Remembering

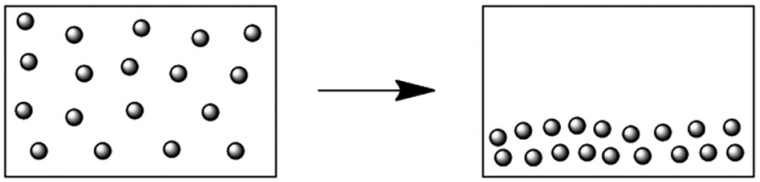
54. A gas forming a liquid is called _____

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. MSC: Remembering

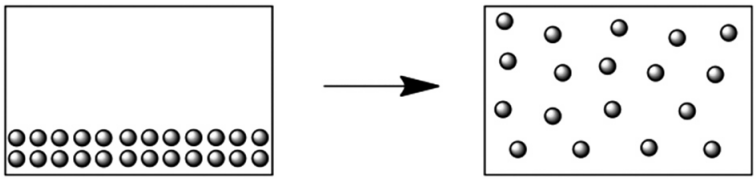
55. What change of state is represented by the following diagram?



a. freezing
b. sublimation
c. vaporization
d. condensation
e. melting

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. MSC: Remembering

56. What change of state is represented by the following diagram?



a. freezing
b. sublimation
c. deposition
d. condensation
e. melting

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. MSC: Remembering

57. 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

58. 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

59. During winter in Siberia, a tenant in a high-rise apartment building dumped a liter of steam (gaseous water) from a container off his balcony. Before it reached the ground, solid snow formed without observation of liquid water. The phase transition described by this process is called _____

a. melting.
b. condensation.
c. deposition.
d. freezing.
e. sublimation.

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

60. 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

61. 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

62. 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

63. Which of the following is a base SI unit?
a. g
b. mmol
c. °C
d. s
e. cm

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

64. Which of the following length measurements is the shortest?
a. a 1.1 cm button
b. a 1.1 × 10^3 mm piece of string
c. a 1.1 μm long insect
d. a 1.1 × 10^{-4} km diameter coin
e. a 0.11 m piece of tape

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

65. 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

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

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

67. The prefix nano corresponds to a factor of _____
a. 10^9.
b. 10^3.
c. 10^{-3}.
d. 10^{-6}.
e. 10^{-9}.

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

68. 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. MSC: Applying

69. 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. MSC: Applying

70. 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.
d. 1.39 × 10^3 km.
e. 1.39 × 10^8 m.

c. 1.39×10^{6} km.

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

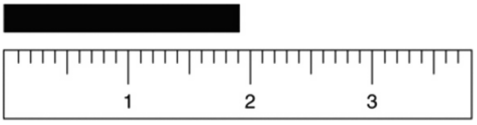
71. Electromagnetic radiation in the mid-infrared region of the spectrum has wavelengths around 0.6 μm. Express this wavelength in meters using exponential notation (1 μm = 10^{-6} m).
a. 1.06×10^{-6} m
b. 1.06×10^{-5} m
c. 1.06 m
d. 1.06×10^{7} m
e. 1.06×10^{5} m

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

72. 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: 1.1
OBJ: Identify the number of significant figures in a measurement.
MSC: Applying

73. 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: 1.1
OBJ: Identify the number of significant figures in a measurement.
MSC: Applying

74. The number 3.42×10^{3} converted from scientific notation would be written as _____ and contain _____ significant figures.
a. 0.00342; three
b. 0.00342; five
c. 3.42; three
d. 3420; three
e. 3420; four

ANS: D DIF: Easy REF: 1.1
OBJ: Identify the number of significant figures in a measurement.
MSC: Applying

75. The measurement 54.40 m contains _____ significant figure(s).
a. one
b. two
c. three
d. four
e. five

ANS: D DIF: Easy REF: 1.1
OBJ: Identify the number of significant figures in a measurement.
MSC: Applying

76. 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: 1.1
OBJ: Express values obtained from measurement and calculation using the appropriate number of significant figures. MSC: Applying

77. 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: 1.1
OBJ: Express values obtained from measurement and calculation using the appropriate number of significant figures. MSC: Applying

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

$$213 - 0.32 + 2.3 - 57.432$$

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

ANS: C DIF: Easy REF: 1.1
OBJ: Express values obtained from measurement and calculation using the appropriate number of significant figures. MSC: Applying

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

$$(4.9) / (17.1 \times 8.943)$$

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

ANS: B DIF: Easy REF: 1.1
OBJ: Express values obtained from measurement and calculation using the appropriate number of significant figures. MSC: Applying

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

$$(2.30) / (21.13 - 1.271)$$

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

ANS: C DIF: Medium REF: 1.1
OBJ: Express values obtained from measurement and calculation using the appropriate number of

significant figures. MSC: Applying

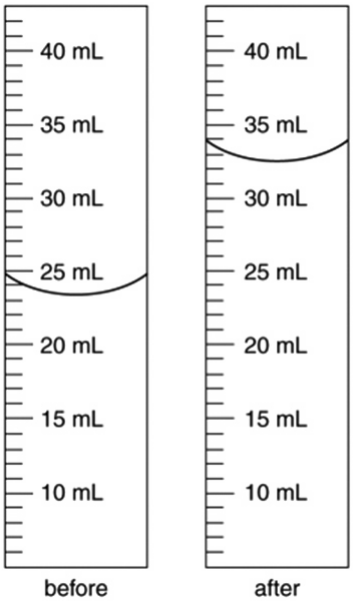
81. If the following operations are carried out, how would the final answer be reported?

$$(14.1 + 12.14) \times 7.45$$

a. 195.19
b. 195.2
c. 195
d. 2.00×10^2
e. 195.5

ANS: C DIF: Medium REF: 1.1
OBJ: Express values obtained from measurement and calculation using the appropriate number of significant figures. MSC: Applying

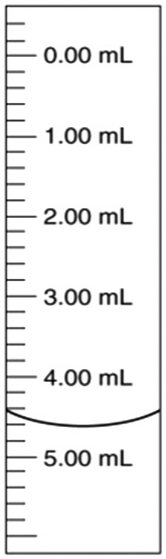
82. An irregularly shaped metal object with a mass of 25.43 g was placed in a graduated cylinder with water. The before and after volumes are shown below. What is the density of the metal?



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: 1.1
OBJ: Express values obtained from measurement and calculation using the appropriate number of significant figures. MSC: Applying

83. 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: 1.1
OBJ: Express values obtained from measurement and calculation using the appropriate number of significant figures. MSC: Applying

84. 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: 1.1
OBJ: Write definitions of precision and accuracy. MSC: Remembering

85. 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: 1.1
OBJ: Identify precision and accuracy in measurements and distinguish between them.
MSC: Applying

86. 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
d. 5.05, sample 4

b. 5.05, sample 2
c. 5.05, sample 3
e. 5.0525, sample 3

ANS: A DIF: Easy REF: 1.1
OBJ: Identify precision and accuracy in measurements and distinguish between them.
MSC: Applying

87. 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)

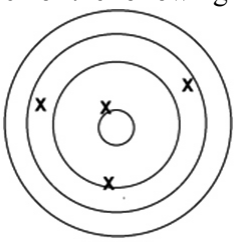
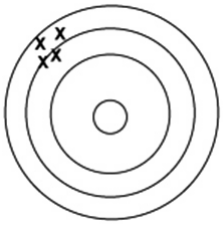
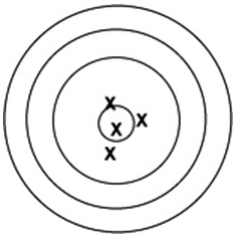
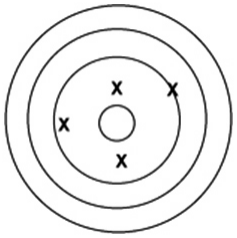
ANS: E DIF: Easy REF: 1.1
OBJ: Identify precision and accuracy in measurements and distinguish between them.
MSC: Applying

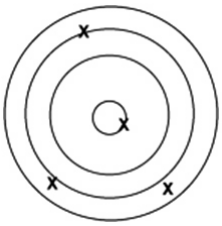
88. As a summer intern at the National Institute of Standards and Technology, a student performed three measurements to determine the density of water at 25°C to four significant figures. She obtained the following results. The known density of water at 25°C to three significant figures is 0.958 g/mL.

Trial	***Density* (g/mL)**
1	5.01
2	4.95
3	5.10

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: 1.1
OBJ: Identify precision and accuracy in measurements and distinguish between them.
MSC: Understanding

89. Which of the following targets was used by a precise but inaccurate archer?
a.

d.

b.

e.


c. 

ANS: D DIF: Easy REF: 1.1
OBJ: Identify precision and accuracy in measurements and distinguish between them.
MSC: Understanding

90. The following measurements of the mass of an aspirin tablet were made by different students in a lab. Each set gives the results of three 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: 1.1
OBJ: Identify precision and accuracy in measurements and distinguish between them.
MSC: Applying

91. 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

92. 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

93. 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

94. 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
d. 18 s
e. 0.43 s

c. 56 s

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

95. 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

96. In celebration of Mole Day, Turbo the snail competed in a race that was a mole (6.02×10^{23}) of zeptometers long. If zepto represents a factor of 10^{-21}, how long was the race in meters?
a. 1.66×10^{-3} m
b. 1.66×10^{-4} m
c. 60.2 m
d. 6.02×10^{2} m
e. 6.02×10^{3} m

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

97. To bake a cake, it requires 16 teaspoons of vegetable oil. How many fluid ounces is that? (1 cup = 48 teaspoons and 1 cup = 8 fl oz)
a. 2.7 fl oz
b. 96 fl oz
c. 4.1×10^{-2} fl oz
d. 0.38 fl oz
e. 24 fl oz

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

98. 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

99. Which of the following choices would correctly use conversion factors and units to convert a measurement in micrometers to kilometers?
a. $\frac{10^6\ m}{1\ \mu m} x \frac{1\ km}{1000\ m}$
b. $\frac{1\ m}{10^6\ \mu m} x \frac{1\ km}{1000\ m}$
c. $\frac{10^6\ \mu m}{1\ m} x \frac{1000\ m}{1\ km}$
d. $\frac{10^6\ m}{1\ \mu m} x \frac{1000\ km}{1\ m}$
e. $\frac{1\ m}{10^6\ \mu m} x \frac{1000\ km}{1\ m}$

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

100. Aroldis Chapman is an MLB relief pitcher who recorded the fastest pitch in a major league game, which was clocked at 105 mi per hour. What was this speed in m/s? (1 mi = 1.609 km)
a. 4.69×10^{-2} m/s
b. 14.3 m/s
c. 46.9 m/s
d. 2.82×10^{2} m/s
e. 6.08×10^{2} m/s

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

101. A temperature of 78°F was recorded yesterday. The forecasted high for today is predicted to be above this temperature. Which of the following could be the expected high temperature?
a. 21°C
b. 24°C
c. 29°C
d. 273 K
e. 290 K

ANS: C DIF: Easy REF: 1.11
OBJ: Convert between temperature scales: Kelvin, Celsius, and Fahrenheit.
MSC: Applying

102. What is the temperature in °C of a reaction mixture that is at 234 K?
a. −507°C
b. −39°C
c. 39°C
d. 234°C
e. 507°C

ANS: B DIF: Easy REF: 1.11
OBJ: Convert between temperature scales: Kelvin, Celsius, and Fahrenheit.
MSC: Applying

103. Room temperature is often taken to be 25°C. What is this temperature in °F?
a. 46°F
b. 45°F
c. 14°F
d. 77°F
e. 72°F

ANS: D DIF: Easy REF: 1.11
OBJ: Convert between temperature scales: Kelvin, Celsius, and Fahrenheit.
MSC: Applying

104. 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: 1.11
OBJ: Convert between temperature scales: Kelvin, Celsius, and Fahrenheit.
MSC: Applying

105. Liquid nitrogen boils at 77 K. What is this temperature in °F?
a. −196°F
b. −321°F
d. −77°F
e. −352°F

c. −256°F

ANS: B DIF: Medium REF: 1.11
OBJ: Convert between temperature scales: Kelvin, Celsius, and Fahrenheit.
MSC: Applying

106. 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: 1.11
OBJ: Convert between temperature scales: Kelvin, Celsius, and Fahrenheit.
MSC: Applying

107. Which temperature is below 300 K?
a. 28°C
b. 30°C
c. 75°F
d. 85°F
e. All the temperatures are below 300 K.

ANS: C DIF: Medium REF: 1.11
OBJ: Convert between temperature scales: Kelvin, Celsius, and Fahrenheit.
MSC: Applying