Chapter 1 Fundamental Concepts and Units of Measurement

Multiple Choice

Section 1.2

1. A broad generalization based on the results of many experiments is called

   a. the scientific method.
   * b. a scientific law.
   c. a theory.
   d. a hypothesis.
   e. an empirical fact.

Section 1.2

2. A tentative explanation used to explain observed facts or laws is called

   a. the scientific method.
   b. a scientific law.
   c. a theory.
   * d. a hypothesis.
   e. an empirical fact.

Section 1.2

3. A scientific law is

   * a. a broad statement based on the results of many experiments.
   b. a tentative explanation for a set of observations that can be tested by further experimentation.
   c. a tested explanation that explains a body of facts related to behavior in nature.
   d. a model used to visualize the invisible.
   e. an undisputed explanation of a scientific principle to which no exception can be found.

Section 1.3

4. Which one of the following does not involve a chemical change?

   a. A fish that is left for some time in an unrefrigerated place decomposes.
   b. Apple juice which is left in an open bottle ferments.
   c. A loaf of bread rises and its volume expands when it is baked in an oven.
   * d. When a lake starts to freeze in winter, ice is formed on the surface.
   e. When sugar is fermented under certain conditions, alcohol is produced.

Section 1.3

5. Which one of the following is a physical change?

   a. When ignited with a match in open air, paper burns.
   * b. In cold weather, water condenses on the inside surface of single pane windows.

c. When treated with bleach, some dyed fabrics change color.
d. When heated strongly, sugar turns dark brown.
e. Grape juice left in an open unrefrigerated container turns sour.

Section 1.3
6. Which one of the following is a chemical change?

* a. When blood is mixed with 3% hydrogen peroxide solution, it changes color.
b. When water is boiled, it forms steam.
c. When a solid stick of butter is heated, it becomes a liquid.
d. When blue paint is mixed with yellow paint, a green color is obtained.
e. When a bar of gold metal is pounded with a hammer, it flattens out.

Section 1.3
7. Which of the following is *not* a chemical change?

a. A nail rusts during a rainstorm.
b. Milk turns sour if left unrefrigerated.
c. Yeast produces carbon dioxide to help bread rise.
d. Copper is molded with heat to form pipes.
* e. Mixing baking soda and vinegar causes fizzing and bubbling.

Section 1.3
8. An example of an element is

a. glucose.
b. table salt.
* c. gold.
d. rust.
e. chalk.

Section 1.3
9. The two types of pure substances are

* a. compounds and elements.
b. compounds and solutions.
c. elements and mixtures.
d. mixtures and solutions.
e. solutions and elements.

Section 1.3
10. An example of a chemical compound is

a. gun metal.
b. brass.
c. bronze.
d. granite.
* e. table salt.

Section 1.4
11. Which is an example of a chemical property?

* a. combustibility
  b. volatility
  c. viscosity
  d. malleability
  e. ductility

Section 1.4
12. Which is an example of an intensive property of matter?

* a. color
  b. volume
  c. mass
  d. weight
  e. length

Section 1.4
13. Each of the following properties of a sample of a pure substance can be used for identification except its

  a. density.
  b. freezing point temperature.
* c. mass.
  d. melting point temperature.
  e. solubility in water.

Section 1.4
14. Which is an example of a chemical reaction?

  a. the separation of air into oxygen, nitrogen, and other components
* b. the separation of a compound into its elements
  c. the separation of gases from liquids
  d. the separation of a mixture into its components
  e. the separation of solids from liquids

Section 1.5
15. Which of the following is an SI base unit?

  a. dyne
  b. newton
  c. milliliter
* d. ampere
  e. joule

Section 1.5
16. The *kilo* is

  a. a unit of mass.
  b. a unit employed in medical terminology.

* c. a decimal multiplier in the metric system.
  d. a unit of speed.
  e. a volume unit employed by the DEA (drug enforcement agency).

Section 1.5
17. The SI base units of temperature and mass, respectively, are

  a. degree and gram.
* b. kelvin and kilogram.
  c. Celsius and milligram.
  d. degree and kilogram.
  e. kelvin and gram.

Section 1.5
18. Which is a unit of surface area?

  a. pascal
  b. joule
* c. square meter
  d. cubic centimeter
  e. kilometer

Section 1.5
19. The SI derived unit for area is

  a. square centimeter.
  b. square yard.
  c. square kilometer.
* d. square meter.
  e. pascal.

Section 1.5
20. The boiling point of barium is 725 $^{\circ}$C. Determine the equivalent value in $^{\circ}$F

  a. 435 $^{\circ}$F
* b. 1337 $^{\circ}$F
  c. 1247 $^{\circ}$F
  d. 1362 $^{\circ}$F
  e. 1273 $^{\circ}$F

Section 1.5
21. The melting point of antimony is listed in one handbook as 630.74 $^{\circ}$C. Determine the equivalent value in $^{\circ}$F.

  a. 382.41 $^{\circ}$F
  b. 1103.3 $^{\circ}$F
  c. 1077.7 $^{\circ}$F
* d. 1167.3 $^{\circ}$F
  e. 1192.9 $^{\circ}$F

Section 1.5

22. On a day in the summer of 1992, the temperature fell from 98 °F to 75 °F in just three hours. The temperature drop expressed in Celsius degrees (°C) was

* a. 13 °C
  b. 41 °C
  c. 45 °C
  d. 9 °C
  e. 75 °C

Section 1.5

23. On a day in the summer of 1976, the temperature fell from 95 °F to 75 °F in just three hours. The temperature drop expressed in Celsius degrees (°C) was

* a. 11 °C
  b. 13 °C
  c. 18 °C
  d. 20 °C
  e. -12 °C

Section 1.5

24. The melting point of antimony is listed in one handbook as 1167.3 °F. Expressed in kelvins this temperature would be

  a. 357.6 K
  b. 496.8 K
  c. 583.7 K
  d. 894.2 K
* e. 903.9 K

Section 1.5

25. The melting point of lead acetate, a white solid, is 280 °C. Determine the melting point of this compound in units of °F

  a. 446 °F
  b. 472 °F
  c. 504 °F
* d. 536 °F
  e. 562 °F

Section 1.5

26. The boiling point of chlorine is -34.6 °C. This temperature expressed in kelvins is

  a. -30.3 K
  b. 177.4 K
* c. 238.6 K
  d. 243.0 K
  e. 307.6 K

Section 1.5

27. A metal alloy melts at 874 K. What is this temperature in °F?

    a. 302 °F
    b. 365 °F
    c. 1050 °F
    d. 1082 °F
    * e. 1114 °F

Section 1.5

28. The boiling point of carbonyl selenide is 251.4 K. What is this temperature in °F?

    * a. - 7.1 °F
    b. - 44.1 °F
    c. - 96.7 °F
    d. 0.00 °F
    e. +18.5 °F

Section 1.5

29. The highest temperature recorded in the athletic field house when the cooling units were being replaced and upgraded was 122.0 °F. Express this temperature in Kelvin units.

    * a. 323.2 K
    b. 337.6 K
    c. 341.0 K
    d. 435.2 K
    e. 492.8 K

Section 1.6

30. A number resulting from a measurement was properly expressed in scientific notation as 3.170×10^{-2} meters (m). The number could also be correctly written as

    a. 0.0317 m
    * b. 0.03170 m
    c. 0.032 m
    d. 317 m
    e. 317.0 m

Section 1.6

31. An electronic balance used in the mailroom displays tenths of a kilogram from 0 to 140 kg. How many significant figures should be used to express the mass of any packages whose mass is between 80.2 and 83.5 kg.?

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

Section 1.6

32. Which response gives the correct number of significant figures for all three of the following measurements? 7.103 cm, 0.00005 inch, and 1.3400×10^{-4} dm^3

a. 3, 5, and 4
b. 3, 1, and 3
c. 4, 1, and 3
* d. 4, 1, and 5
e. 4, 5, and 5

Section 1.6

33. After evaluating the expression,

$$\frac{13.726 + 0.027}{8.221}$$

how many significant figures should be displayed in the result?

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

Section 1.6

34. How many significant figures should be displayed in the result of the operation, 8.5201 + 1.93?

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

Section 1.6

35. When the expression, 412.272 + 0.00031 - 1.00797 + 0.000024 + 12.8, is evaluated, the result should be expressed as

a. 424
b. 424.0
* c. 424.1
d. 424.06
e. 424.064364

Section 1.6

36. When the expression, 16.0200 + 0.00048 - 11.184 - 221.1, is evaluated, the result should be expressed as

* a. -216.3
b. -216.26
c. -216.2635
d. -216.26352

e. -2.2×10^2

Section 1.6

37. When a student evaluates the expression,

$$\frac{0.04616 \times 0.082057 \times 293.30}{0.654}$$

the result should be expressed as

a. 1.69
* b. 1.70
c. 1.699
d. 1.6987
e. 1.69870

Section 1.6

38. When a student evaluates the expression

$$\frac{4.268 \times 0.082057 \times 373.15}{\frac{744.6}{760.0} \times 2.688}$$

the result should be expressed as

a. 49.623
b. 49.631
* c. 49.62
d. 49.63
e. 49.623202

Section 1.6

39. The number 0.0030600 is properly expressed in scientific notation as

a. 3.0600×10^{-2}
b. 0.30600×10^{-2}
c. 0.306×10^{-2}
d. 3.06×10^{-3}
* e. 3.0600×10^{-3}

Section 1.6

40. The number 0.02100 is properly expressed in scientific notation as

a. 0.21×10^{-1}
b. 2.1×10^{-2}
* c. 2.100×10^{-2}
d. 21.0×10^{-3}
e. 2.10×10^{-2}

Section 1.7
41. The SI prefixes giga and micro indicate, respectively:

* a. 10^{9} and 10^{-6}
  b. 10^{-9} and 10^{-6}
  c. 10^{6} and 10^{-3}
  d. 10^{3} and 10^{-3}
  e. 10^{-9} and 10^{-3}

Section 1.7
42. The SI prefixes mega and nano indicate, respectively:

  a. 10^{9} and 10^{-6}
  b. 10^{-6} and 10^{9}
* c. 10^{6} and 10^{-9}
  d. 10^{6} and 10^{9}
  e. 10^{-6} and 10^{-9}

Section 1.7
43. A distance of 18×10^{-3} meters is equal to

  a. 1.8 micrometers.
  b. 1.8 millimeters.
  c. 0.18 meters.
* d. 1.8 centimeters.
  e. 18 kilometers.

Section 1.7
44. The diameter of a certain atom was found to be 2.35×10^{-8} cm. How many nanometers is this?

  a. 2.35×10^{1} nm
  b. 2.35×10^{-19} nm
  c. 2.35×10^{-15} nm
* d. 2.35×10^{-1} nm
  e. 2.35×10^{-10} nm

Section 1.7
45. How many micrometers are there in 3.672 km?

  a. 3.672×10^{6}
  b. 2.723×10^{-7}
  c. 2.723×10^{-4}
* d. 3.672×10^{9}
  e. 3.672×10^{3}

Section 1.7
46. How many mm (millimeters) are there in 6.3 km?

a. 6.3×10^{-5} mm
b. 6300 mm
c. 6.3×10^{4} mm
d. 6.3×10^{5} mm
* e. 6.3×10^{6} mm

Section 1.7
47. How many cm^3 are in 0.00424 dm^3?

a. 0.0424 cm^3
b. 0.424 cm^3
* c. 4.24 cm^3
d. 0.00000424 cm^3
e. 424 cm^3

Section 1.7
48. How many cubic inches are in 1.00 dm^3? 1 in. = 2.54 cm.

* a. 61.0 in^3
b. 155 in^3
c. 394 in^3
d. 1.64×10^{4} in^3
e. 383×10^{2} in^3

Section 1.7
49. Which one of the following represents the smallest distance?

* a. 4.5 mm
b. 0.20 inch
c. 0.83 cm
d. 0.73 m
e. 0.30 yard

Section 1.7
50. How many square meters are in a rectangular piece of carpet which measures 12.0 feet by 22.0 feet? 1 m = 39.37 in., 1 ft = 12 in.

* a. 24.5 m^2
b. 28.4 m^2
c. 866 m^2
d. 80.5 m^2
e. 966 m^2

Section 1.7
51. How many square meters of floor space are in a room which has 225.0 square yards of floor space? 1 m = 39.37 in., 1 yard = 36 in.

* a. 188.1 square meters
b. 269.0 square meters
c. 246.0 square meters

d. 205.7 square meters
e. 172.0 square meters

Section 1.7

52. If a car has an EPA mileage rating of 3.0×10^1 miles per gallon, what is this rating in m L^{-1}? 1 liter = 1 dm^3, 1 gallon = 3.785 liter, 1 mile = 1.609 meter.

* a. 13 m L^{-1}
b. 200 m L^{-1}
c. 180 m L^{-1}
d. 70 m L^{-1}
e. 11 m L^{-1}

Section 1.7

53. How many m^3 are in a 1.5 L bottle of soda?

a. 1.5×10^1 m^3
* b. 0.0015 m^3
c. 0.015 m^3
d. 0.00015 m^3
e. 1.5 m^3

Section 1.7

54. One radio station operates on an assigned frequency of 96.3 megahertz while another one operates on an assigned frequency of 1280 kilohertz. What is the ratio of the larger to the smaller value?

a. 13.3
b. 13.29
* c. 75.2
d. 75.23
e. 13.2918

Section 1.7

55. One radio station operates on an assigned frequency of 88.1 megahertz while another one operates on an assigned frequency of 1460 kilohertz. What is the ratio of the larger to the smaller value?

a. 16.5
b. 16.57
c. 16.57208
* d. 60.3
e. 60.342

Section 1.7

56. An industrial container was filled with 210.8 liters of a solvent. How many gallons of solvent does this container contain?
1 pint(pt) = 473.2 mL, 1 gallon(gal) = 8 pt exactly.

a. 55.00 gal
* b. 55.69 gal

c. 59.15 gal
d. 179.1 gal
e. 798.0 gal

Section 1.8

57. The density of cadmium metal is 8.642 g/cm^3. Given that 1 foot(ft) = 12 inches(in.), 1 in. = 2.54 cm, and 1 pound (lb) = 453.6 g, what is the density of cadmium in lb/ft^3?

a. 17.70 lb/ft^3
b. 141.6 lb/ft^3
* c. 539.5 lb/ft^3
d. 263.4 lb/ft^3
e. 327.7 lb/ft^3

Section 1.8

58. The density of chromium metal is 7.20 g/cm^3. Given that 1 foot(ft) = 12 inches(in.), 1 in. = 2.54 cm, and 1 pound (lb) = 453.6 g, what is the density of chromium in lb/ft^3?

a. 14.7 lb/ft^3
b. 118 lb/ft^3
* c. 449 lb/ft^3
d. 219 lb/ft^3
e. 393 lb/ft^3

Section 1.8

59. The density of copper metal is 8.92 g/cm^3. Given that 1 foot(ft) = 12 inches(in.), 1 in. = 2.54 cm, and 1 pound (lb) = 453.6 g, what is the density of copper in lb/ft^3?

a. 18.3 lb/ft^3
b. 146 lb/ft^3
* c. 557 lb/ft^3
d. 272 lb/ft^3
e. 317 lb/ft^3

Section 1.8

60. The density of gold, expressed in non-SI units is 19.3 g/cm^3. In SI units the density is

a. 0.0193 kg/cm^3
b. 19.3 x 10^3 kg/cm^3
* c. 19.3 x 10^4 kg/m^3
d. 193 kg/m^3
e. 19.3 x 10^{-3} kg/m^3

Section 1.8

61. An empty volumetric flask, weighing 27.16 grams, has a volume of 100.4 cm^3. How much would it weigh when filled with bromine, an element that has a density of 3.1028 g/cm^{-3}?

a. 59.51 g
b. 284.4 g
c. 311.5 g

* d. 338.7 g
e. 395.8 g

Section 1.8

62. How many cm^3 of water will overflow from a full container of water if a 52.5 gram sample of nickel (density = 8.90 g/cm^{-3}) is carefully placed in the container so there is no splashing, just overflowing?

a. 467 cm^3
b. 0.170 cm^3
* c. 5.90 cm^3
d. 43.6 cm^3
e. 61.4 cm^3

Section 1.8

63. How many cm^3 of water will overflow from a full container of water if a 66.7 gram sample of vanadium (density = 6.11 g/cm^{-3}) is carefully placed in the container so there is no splashing, just overflowing?

a. 11.9 cm^3
b. 9.92 cm^3
c. 60.6 cm^3
* d. 10.9 cm^3
e. 0.0916 cm^3

Section 1.8

64. A sample of zinc metal (density = 7.14 g/cm^{-3}) was submerged in a graduated cylinder containing water. The water level rose from 162.5 cm^3 to 186.0 cm^3. How many grams did the sample weigh?

* a. 168 g
b. 22.7 g
c. 26.1 g
d. 48.8 g
e. 3.29 g

Section 1.8

65. A sample of an alloy (density = 9.62 g cm^{-3}) was submerged in a graduated cylinder containing water. The water level rose from 166.5 cm^3 to 182.0 cm^3. How many grams did the sample weigh?

a. 0.621 g
b. 175 g
c. 18.9 g
d. 17.8 g
* e. 149 g

Section 1.8

66. "Isooctane", a fuel used in gasoline engines because it has an antiknock octane rating of 100, has a density of 0.6919 g cm^{-3}. How many pounds would 20.4 gallons of this fuel (a typical full tank) weigh? 1 gallon = 3785 cm^3 = 4 quart; 1 pound = 453.6 g

a. 77.2 pounds
b. 246 pounds

* c. 118 pounds
d. 24.2 pounds
e. 50.6 pounds

Section 1.8

67. Mercury, which has a density of 13.595 g cm^{-3}, is usually stored in iron vessels for shipment. These vessels typically have a capacity of 2.60 liters. How many pounds of mercury would a filled container hold? 1 pound = 0.4536 kg, 1 liter = 1 dm^3 = 1000 cm^3.

* a. 77.9 pounds
b. 86.7 pounds
c. 11.5 pounds
d. 16.0 pounds
e. 42.6 pounds

Section 1.8

68. Iron has a density of 7.86 g cm^{-3}. How many pounds does a block of iron with a volume of 1.65 cubic feet weigh? 1 pound = 0.4536 kg, 1 foot = 12 in., 1 in. = 2.54 cm.

* a. 810 pounds
b. 0.871 pounds
c. 871 pounds
d. 491 pounds
e. 3.01 pounds

Section 1.8

69. Gold has a density of 19.3 g cm^{-3}. How many pounds does a gold sphere weigh if it has a diameter of 5.20 inches? 1 pound = 0.4536 kg. The volume of a sphere $= \frac{4}{3}(\pi r^3)$.

a. 16.3 pounds
b. 19.7 pounds
* c. 51.3 pounds
d. 63.7 pounds
e. 411 pounds

Section 1.8

70. A spherical cannonball which has a volume given by

$$\frac{4}{3}(\pi r^3)$$

is made of an iron alloy and has a diameter of 9.55 inches and a density of 7.89 g cm^{-3}. How many pounds does this cannonball weigh? 1 pound = 0.4536 kg, 1 inch = 2.54 cm.

a. 59.0 pounds
* b. 130 pounds
c. 41.4 pounds
d. 124 pounds
e. 21.0 pounds

Section 1.8

71. Iridium has a density of 22.65 g cm^{-3}. A student has an iridium figurine on his desk which weighs 11.50 pounds. What is its volume, in cubic inches? 1 pound = 0.4536 kg, 1 inch = 2.54 cm.

a. 5.533 cubic inches
b. 9.410 cubic inches
* c. 14.05 cubic inches
d. 35.70 cubic inches
e. 90.67 cubic inches

Section 1.8

72. The metric equivalent of a 55 gallon drum has a volume of 0.200 cubic meters. One such drum was filled with a colorless liquid, Sukanol, which has a density of 1.168 g cm^{-3}. How many kg should this quantity of Sukanol weigh? 1000 cm^3 = 1L, 1000L =1 m^3

a. 24.3 kg
* b. 234 kg
c. 243 kg
d. 2.34 x 10^5 kg
e. 500 kg

Section 1.8

73. The metric equivalent of a 55 gallon drum has a volume of 0.200 cubic meters. One such drum was filled with a colorless liquid, Sukanol, which has a density of 1.168 g cm^{-3}. How many pounds should this quantity of Sukanol weigh? 1000 cm^3 = 1L, 1000L =1 m^3

a. 53.6 lb
* b. 515 lb
c. 536 lb
d. 5.15 x 10^5 lb
e. 1102 lb

Section 1.8

74. A 55.25 gallon container was filled with an industrial solvent whose density is 1.146 g/cm^3. How many kg should the solvent in the container weigh? 1 gallon(gal) = 3.785 liters(L)

a. 23.9 kg
* b. 239.7 kg
c. 239 kg
d. 2.39 x 10^5 kg
e. 500 kg

Section 1.8

75. The density of iron is 7.86 g cm^{-3}. What is the mass (in kg) of 20.00 cubic inches of iron? 1 inch = 2.54 cm, exactly.

a. 6.46 x 10^{-3} kg
b. 4.17 x 10^{-2} kg
c. 0.393 kg
d. 2.54 kg
* e. 2.58 kg

Section 1.8

76. Acetone has a density of 0.791 g/mL. If 1 gallon = 3.7854 liters, how many kg should the contents of a 5.00 gallon container filled with acetone weigh?

    a. 1.045 kg
    b. 12.6 kg
    c. 13.8 kg
    * d. 15.0 kg
    e. 23.9 kg

Fill in the Blank

Section 1.5

77. Many home freezers maintain a temperature of 0.0 ^{o}F. Express this temperature in $^{\circ}$C. _____ (-17.8 $^{\circ}$C)

Section 1.5

78. A kilometer is _____ times longer than a centimeter. (10^5)

Section 1.5

79. A 201 g sample weighs _____ mg. (2.01×10^5 mg)

Section 1.6

80. How many significant digits are there in the number 1.050×10^9? _____ (4)

Section 1.6

81. Express the result of the operation, 8.520 + 2.7, to the proper number of significant digits. _____ (11.2)

Section 1.6

82. How many significant figures does the number 30.340 contain? _____ (5)

Section 1.7

83. What will be the cost, in dollars, of gasoline for a 3170 mile trip in a car pulling a trailer that delivers 13.30 miles per gallon, if the average price of gas is $1.449 cents per gallon? _____ ($345.36--$345.40)

Section 1.7

84. What will be the cost of gasoline for a 4710 mile automobile trip if the car delivers 27.35 miles per gallon of gasoline, and the average price of gas is $1.249 per gallon? _____ ($215.09)

Section 1.7

85. A spot on a microchip which is 7500 nm (nanometers) in diameter is _____ pm (picometers) in diameter. (7.500×10^6 pm)

Section 1.7

86. An object weighing 450 kg, expressed in megagrams (Mg), is _____ Mg. (0.450 Mg)

True and False

Section 1.3
87. Density is one of the extensive properties of matter. ___ (F)

Section 1.3
88. The volume of a sample is an extensive property of matter. ___ (T)

Section 1.3
89. A sample of a pure compound contains two or more phases. ___(F)

Section 1.4
90. A homogeneous mixture consists of only one chemical substance. ___ (F)

Section 1.4
91. A mixture always contains more than one chemical substance. ___ (T)

Section 1.4
92. A mixture can exist as only a single phase.___(T)

Section 1.5
93. A liter of carbon tetrachloride is smaller than a quart of the same substance. ___ (F)

Section 1.5
94. An increase of one Kelvin in temperature is a smaller change than an increase of one degree Fahrenheit. ___ (F)

Section 1.6
95. A large crowd attending a celebration in a metropolitan area was described as 450,000 in the morning newspaper the next day. A chemistry student stated that, mindful of the purpose of using scientific notation, this should be correctly expressed in scientific notation as 4.50000×10^5. The number expressed this way truly represents the crowd size, true or false? ___ (F)

Section 1.6
96. Any number known accurately to six or more significant digits is defined as an exact number. ___ (F)

Section 1.6
97. In determining the number of significant digits in the result of a calculation, exact numbers are considered as having a value to six significant digits. ___ (F)

Section 1.6
98. Ambiguity in the number of significant digits in a number being expressed can be eliminated by proper use of scientific notation. ___ (T)

Section 1.6
99. The result of the operation, 8.52010 x 7.9, should be expressed as 67.3088. ___ (F)

Section 1.7
100. A 15 km distance run is a shorter run than a 10 mile distance run. ___ (T)

Section 1.7
101. A 5.00 pound bag of sugar weighs more than a 2.50 kg bag of sugar. ___ (F)

Section 1.7
102. A piece of carpet which measures 44.0 square yards is smaller than a piece of carpet which measures 44.0 square meters. ___ (T)

Critical Thinking Questions

Section 1.5
1103. A young high school student has invented a new temperature scale, the Zuban scale (his last name, of course). In common with the Kelvin, Celsius, and Fahrenheit scales, it is a linear scale. According to Zuban,

1) the boiling point of water which is 100.00 $^{\circ}$C = 373.15 K = 0.00 $^{\circ}$Z
2) the boiling point of sulfur which is 444.60 $^{\circ}$C = 717.75 K = 250.00 $^{\circ}$Z
3) the melting point of silver which is 960.15 $^{\circ}$C = 1233.30 K = 624.02 $^{\circ}$Z

Calculate the value of absolute zero on the Zuban Scale. _____ (-270.71 $^{\circ}$Z)

Section 1.5
104. Carl, a ninth grade whiz kid, has invented a new temperature scale, the Vitellan scale (his last name, of course). In common with the Kelvin, Celsius, and Fahrenheit scales, it is a linear scale. According to Carl,

1) the melting point of benzene which is 5.53 $^{\circ}$C = 0.00 $^{\circ}$V
2) the boiling point of benzene which is 80.10 $^{\circ}$C = 100.00 $^{\circ}$V
3) the melting point of lead which is 327.50 $^{\circ}$C = 431.77 $^{\circ}$V

Calculate the value for the melting point of mercury (-38.86 $^{\circ}$C) on the Vitellan scale. _____ (-59.53 $^{\circ}$V)

Section 1.6
105. A number resulting from a measurement was properly expressed in scientific notation as 2.1 x 10^{-3} meters (m). The number could also be correctly written as

* a. 0.0021 m
b. 0.002100 m
c. 0.00021 m
d. 2.1000 m
e. 21000 m

Section 1.8
106. Consider this data from a lab, concerning the mass and the volume of water displaced in a graduated cylinder by introduction of a metal sample to the cylinder:

Mass of weighing cup = 0.452 g
Mass of weighing cup + metal sample = 72.943 g
Volume of water in cylinder = 15.2 cm^3

When the metal sample was carefully lowered into the graduated cylinder, the water above the submerged metal sample rose to the 19.0 cm^3 mark. What is the density of the metal?

a. 2.2 g cm^{-3}
b. 3.8 g cm^{-3}
c. 4.8 g cm^{-3}
* d. 19 g cm^{-3}
e. 19.2 g cm^{-3}

Section 1.8

107. A spherical cannonball made of an iron alloy has a specific gravity of 7.88, and weighs 22.12 pounds. It has a diameter of 13.46 cm. On the other hand, spent uranium (from processing which removes the commercially important rare isotope) has a specific gravity of 19.05. How many pounds would a uranium cannonball of the same dimensions as the iron cannonball weigh?

volume $\frac{4}{3}(\pi r^3)$ _____ (53.5 pounds)

Section 1.8

108. A spherical cannonball made of an iron alloy has a density of 7.86 g cm^{-3}, and weighs 22.12 pounds. On the other hand, spent uranium (from processing which removes the commercially important rare isotope) has a density of 19.05 g cm^{-3}. What would be the diameter, in cm, of a uranium round shot which has exactly twice the weight as the iron ball described above? 1 pound = 0.4536 kg.

volume $\frac{4}{3}(\pi r^3)$ _____ (12.62 cm)

Section 1.8

109. Some students in the AP chemistry class have come up with an idea they would like to have tested which involves collaboration with two or three DOD facilities. They want to test two small muzzle loading cannons like the ones used in the 18^{th} century. One would be using spherical cannonballs made of iron, while the other would be using spherical cannonballs made of spent uranium. Both cannons will be using cannonballs with a diameter of 5.000 inches. If uranium has a density of 19.05 g cm^{-3}, what would be the mass, in pounds, of the uranium cannonballs? 1 pound = 453.6 g, 1 inch = 2.54 cm exactly. volume $\frac{4}{3}(\pi r^3)$ _____ (* 45.04 pounds)

Section 1.8

110. If 1 meter = 39.37 inch and 1 foot = 12.00 inch, calculate the relationship to four significant digits, which will convert cubic feet into cubic meters directly. 1 ft^3 = _____ m^3 (0.02832)

Section 1.8

111. Iron has a density of 7.86 g cm^{-3}. As part of their exam, students in the junior class at a boarding school were to weigh a metal sphere, measure its diameter and calculate its density. Some of the seniors sneaked into the lab the weekend before, took the iron sphere, took it downtown, and had the interior partially hollowed and the surface repaired so it wouldn't be noticed and replaced it in the cabinet late on Sunday. The junior students who had this iron sphere for their "unknown" obtained 9.30 cm for the diameter and 2.44 kg for the mass. What value should they have reported for the mass of the sphere if it had not been tampered with, and what was the volume of the hollowed out space in the interior of the sphere? volume $\frac{4}{3}(\pi r^3)$ _____

(3.31 kg and 111 cm^3)

Short Answer

112. A person creates quite a lot of chalk dust when writing on a chalkboard. Is the formation from a piece of chalk dust a physical or chemical change? Explain your reasoning. Chalk is composed of $CaCO_3$.

(The formation of chalk dust is a physical change. The dust that is formed is still $CaCO_3$, not another chemical species.)

113. Rain is composed of water and matter such as dust and pollen. In highly polluted areas, rain has high concentrations of chemicals such as SO_2, SO_3, and NO_2 dissolved in it. Based on this information, is rain a purely heterogeneous or homogeneous mixture, or is it in both? Explain your reasoning.

(Rain is both. Water containing SO_2, SO_3, and NO_2 would be a homogenous mixture. Pollen and dust, however, would separate out from water and make a heterogeneous mixture.)

114. Sherlock Holmes has a mystery on his hands. His beloved pipe, a gift from the Queen herself, is missing. The only clues he has are a trail of tobacco and the scent of pipe smoke coming from Watson's room. *Using all steps of the scientific method*, describe what Holmes should do to solve the mystery of the missing pipe.

(There are many ways to interpret this question. Holmes needs to come up with a hypothesis, and then use observations to support it. Two of these observations are the trail of tobacco leading to Watson's room, and the scent of pipe smoke coming from Watson's room. This might lead Holmes to hypothesize that Watson has the pipe.)

115. The United States imports 11 million barrels of oil per day. All OPEC (Organization of Petroleum Exporting Countries) members have a combined total of 721 billion barrels of reserve oil. If the United States were the only consumer of this oil, how long would it take for the US to deplete these reserves? Assuming Europe also imports the same amount of oil, how long would it take to deplete these reserves?

(721,000,000,000 barrels x $\frac{1 \text{ day}}{11000000 \text{ barrels}}$ x $\frac{1 \text{ year}}{365 \text{ days}}$ = 1.8×10^2 years. If Europe consumes the same amount, this time would be cut in half.)

116. A barrel of beer sits in a bar's basement. What type of solution is this? If the brewer notices two phases unexpectedly forming, what type of solution must this be? Using the scientific method, what can be said about the barrel of beer?

(The solution should be homogeneous. One conclusion that can be drawn is the beer is probably spoiled.)