CHAPTER 2

Measurements and Calculations

CHAPTER ANSWERS

1. A measurement is a quantitative observation consisting of a *number* and the *units* in which the number was measured.

2. "Scientific notation" means we have to put the decimal point after the first significant figure and then express the order of magnitude of the number as a power of ten. So we want to put the decimal point after the first two:

   $$\frac{63.5\ \text{g}}{125\ \text{cm}^3}$$

   To be able to move the decimal point three places to the left in going from 2,421 to 2.421, means I will need a power of 10^3 after the number, where the exponent three shows that I moved the decimal point three places to the left.

   $$2{,}421 \rightarrow 2.421\times10^{\text{to some power}} = 2.421\times10^3$$

3. If the number is greater than one, the exponent is positive; if the number is less than one, the exponent is negative.

   a. positive

   b. negative

   c. positive

   d. negative

4. If the number is greater than one, the exponent is positive; if the number is less than one, the exponent is negative.

   a. negative

   b. positive

   c. negative

   d. positive

5.

   a. The decimal point must be moved two places to the left: 0.0431

   b. The decimal point must be moved three places to the right: 9540

   c. The decimal point must be moved five places to the left: 0.0000379

   d. The decimal point must be moved two places to the right: 719

6.

a. already a decimal number

b. The decimal point must be moved three places to the right: 1995

c. The decimal point must be moved two places to the right: 199.5

d. The decimal point must be moved four places to the left: 0.0001995

7.

a. The decimal point must be moved three spaces to the right, so the exponent is negative: $0.005291 = 5.219 \times 10^{-3}$.

b. The decimal point must be moved three spaces to the left, so the exponent is positive: $5219 = 5.219 \times 10^{3}$.

c. The decimal point must be moved six spaces to the left, so the exponent is positive: $6{,}199{,}291 = 6.199291 \times 10^{6}$.

d. The decimal point must be moved one space to the right, so the exponent is negative: $0.1973 = 1.973 \times 10^{-1}$.

e. The decimal point must be moved seven spaces to the left, so the exponent is positive: $93{,}000{,}000 = 9.3 \times 10^{7}$.

f. In 72.41, the decimal point must be moved one place to the left, so the exponent of this term is positive: $72.41 = 7.241 \times 10^{1}$. This result must then be combined with the additional power of 10 indicated: $72.41 \times 10^{-2} = 7.241 \times 10^{-1}$.

g. For 0.007241, the decimal point must be moved three spaces to the right, so the exponent of this term is negative: $0.007241 = 7.241 \times 10^{-3}$. This result must then be combined with the additional power of 10 indicated: $0.007241 \times 10^{-5} = 7.241 \times 10^{-8}$.

h. The decimal does not have to be moved (zero spaces), so the exponent is zero: $1.00 = 1.00 \times 10^{0}$.

8.

a. The decimal point has to be moved three places to the right, so the exponent will be 3.

b. The decimal point has to be moved four places to the left, so the exponent will be –4.

c. The decimal point has to be moved two places to the right, so the exponent will be 2.

d. This number is already written as a power of ten but is not in *standard* scientific notation; realizing that $0.994 = 9.94 \times 10^{1}$ and combining exponents gives the final exponent as 1.

9.

a. eight spaces to the right

b. three spaces to the left

c. six spaces to the left

d. 4 spaces to the right

10.
- a. five spaces to the right
- b. three spaces to the left
- c. eight spaces to the left
- d. three spaces to the right

11. To say that scientific notation is in *standard* form means that you have a number between one and ten followed by an exponential term.
- a. The decimal point must be moved three spaces to the left, so the exponent will be three: 4.491×10^3.
- b. 0.321 must first be converted to 3.21×10^1 and then the exponents combined: 3.21×10^2.
- c. The decimal point must be moved one space to the left, so the exponent will be one 9.321×10^1.
- d. 491.5 must first be converted to 4.915×10^2 and then the exponents combined: 4.915×10^{-2}.
- e. 78.95 must first be converted to 7.895×10^1 and then the exponents combined: 7.895×10^4.
- f. 531.2 must first be converted to 5.321×10^2 and then the exponents combined: 5.321×10^{-4}.

12.
- a. The decimal point must be moved four places to the left: 0.0004915.
- b. The decimal point must be moved three spaces to the right: 994.
- c. The decimal point must be moved three spaces to the left: 0.02495.
- d. already a decimal number
- e. The decimal point must be moved two spaces to the right: 693.4.
- f. The decimal point must be moved one space to the right: 693.4.

13.
- a. $1/1033 = 9.681 \times 10^{-4}$
- b. $1/10^5 = 1 \times 10^{-5}$
- c. $1/10^{-7} = 1 \times 10^7$
- d. $1/0.0002 = 5 \times 10^3$
- e. $1/3{,}093{,}000 = 3.233 \times 10^{-7}$
- f. $1/10^{-4} = 1 \times 10^4$
- g. $1/10^9 = 1 \times 10^{-9}$
- h. $1/0.000015 = 6.7 \times 10^4$

14.
- a. $1/0.00032 = 3.1 \times 10^3$
- b. $10^3/10^{-3} = 1 \times 10^6$
- c. $10^3/10^3 = 1\ (1 \times 10^0)$; any number divided by itself is unity.

d. $1/55{,}000 = 1.8 \times 10^{-5}$

e. $(10^5)(10^4)(10^{-4})/10^{-2} = 1 \times 10^7$

f. $43.2/(4.32 \times 10^{-5}) = \dfrac{4.32 \times 10^1}{4.32 \times 10^{-5}} = 1.00 \times 10^6$

g. $(4.32 \times 10^{-5})/432 = \dfrac{4.32 \times 10^{-5}}{4.32 \times 10^2} = 1.00 \times 10^{-7}$

h. $1/(10^5)(10^{-6}) = 1/(10^{-1}) = 1 \times 10^1$

15. kilogram
16. time
17.
   a. 10^3
   b. 10^3
   c. 10^9
   d. 10^6
   e. 10^{-3}; 10^{-2}
   f. 10^6
18.
   a. 10^{-2}
   b. 10^6
   c. 10^9
   d. 10^{-1}
   e. 10^{-3}
   f. 10^{-6}
19. Since a meter is slightly longer than a yard, the floor will require about 25 yd^2 of linoleum.
20. Since a pound is 453.6 g, the 125-g can will be slightly less than ¼ pound.
21. Since a liter is slightly more than a quart, and since 4 qt make 1 gal, 48 L will be approximately 12 gallons.
22. Since 1 in = 2.54 cm, the nail is approximately an inch long.
23. Since a mile is approximately 1.6 km, this distance is about 65 km.
24. Since a liter is slightly more than a quart, the 2–L bottle is larger.
25. 5.22 cm
26. 1.62 m is approximately 5 ft, 4 in. The woman is slightly taller.

27.

a. kilometers

b. meters

c. centimeters

d. millimeters or micrometers

28.

a. centimeter

b. meter

c. kilometer

29.

a. about 4 L

b. about half a liter (500 mL)

c. about 1/4 of a liter (250 mL)

30. d (The other units would give very large numbers for the distance.)

31. Table 2.6 indicates that a dime is 1 mm thick.

$$10\,\text{cm} \times \frac{10\text{ mm}}{1\text{ cm}} \times \frac{1\text{ dime}}{1\text{ mm}} \times \frac{\$1.00}{10\text{ dimes}} = \$10$$

32. Table 2.6 indicates that a nickel coin weighs about 5 g; 1 kg = 1000 g: so

$$\frac{1000\text{ g}}{5\text{ g/nickel}} = \text{about 200 nickels.}$$

33. When we use a measuring scale to the *limit* of precision, we *estimate* between the smallest divisions on the scale. Because this is our best estimate, the last significant digit recorded is uncertain.

34. uncertainty

35. The third figure in the length of the pin is uncertain because the measuring scale of the ruler has *tenths* as the smallest marked scale division. The length of the pin is given as 2.8*5* cm (rather than any other number) to indicate that the point of the pin appears to the observer to be *halfway* between the smallest marked scale divisions.

36. The scale of the ruler shown is marked only to the nearest *tenth* of a centimeter; writing 2.850 would imply that the scale was marked to the nearest *hundredth* of a centimeter (and that the zero in the thousandths place had been estimated).

37.

a. one

b. four

c. five

d. one

e. one

38.

a. one

b. infinite (definition)

c. infinite (fixed number)

d. two

e. probably two

39. increase the preceding digit by one

40. It is better to round off only the final answer and to carry through extra digits in intermediate calculations. If there are enough steps to the calculation, rounding off in each step may lead to a cumulative error in the final answer.

41.

a. 9.31×10^7

b. 2.99×10^{-6}

c. 4.88×10^{-5}

d. 7.90×10^9

e. 4.92×10^{-7}

42.

a. 9.96×10^{-1}

b. 4.40×10^3

c. 8.22×10^{-1}

d. 4.00×10^{-9}

e. 8.42×10^{-2}

43.

a. 4.34×10^5

b. 9.34×10^4

c. 9.916×10^1

d. 9.327×10^0

44.

a. 8.8×10^{-4}

b. 9.375×10^4

c. 8.97×10^{-1}

d. 1.00×10^3

45. The product can have only as many significant figures as the multiplier with the fewest number of significant figures. For example, in the multiplication (9.99994)(4.22221)(3.2), the product could have only two significant figures because the third multiplier has only two significant figures.

46. The total mass would be determined by the number of decimal places available on the readout of the scale/balance. For example, if a balance whose readout is to the nearest 0.01 g were used, the total mass would be reported to the second decimal place. For example, 32.05 g + 29.15 g + 31.09 g would be reported as 92.29 g to the second decimal place. For the calculation 44.05 g + 33.91 g + 48.38 g, the sum would be reported as 126.34 g (a total of five significant figures, but given to the second decimal place).

47. three (based on 2.31 having three significant figures)

48. Most calculators would display 0.66666666. If the 2 and 3 were *experimentally determined* numbers, this quotient would imply far too many significant figures.

49. two decimal places (based on 2.11 being known only to the second decimal place)

50. none

51.

a. 102.623 (The answer can be given only to the third decimal place because 97.381 is known only to the third decimal place.)

b. 236.2 (The answer can be given only to the first decimal place because 171.5 is known only to the first decimal place.)

c. 3.0814 (The answer can be given only to the fourth decimal place because 1.2012 is known only to the fourth decimal place)

d. 4.67 (The answer can be given only to the second decimal place because 13.21 is known only to the second decimal place.)

52.

a. 5.16 (The answer can be given only to the second decimal place because 3.04 is known only to the second decimal place.)

b. 2423 (2.423×10^3; the numbers have to be expressed in the same power of 10 before adding 2119 + 304 = 2423)

c. 0.516 (5.159×10^{-1}; both numbers are the same power of 10)

d. 2423 (This is the same problem as part b only the numbers were not expressed in scientific notation.)

53.

a. two (based on 1.1 having only two significant figures)

b. two (based on 0.22 having only two significant figures)

c. two (based on 0.00033 having only two significant figures)

d. three (assuming sum in numerator is considered to second decimal place)

54.

a. one (the factor of two has only one significant figure)

b. four (the sum within the parentheses will contain four significant figures)

c. two (based on the factor 4.7×10^{-6} having only two significant figures)

d. three (based on the factor 63.9 having only three significant figures)

55.

a. $2.3232 + 0.2034 - 0.16 \times (4.0 \times 10^3) =$

$2.3666 \times (4.0 \times 10^3) = 9.4664 \times 10^3 = 9.5 \times 10^3$

b. $1.34 \times 10^2 + 3.2 \times 10^1/(3.32 \times 10^{-6}) = 13.4 \times 10^1 + 3.2 \times 10^1/(3.32 \times 10^{-6}) =$

$16.6 \times 10^1/(3.32 \times 10^{-6}) = 5.00 \times 10^7$

c. $(4.3 \times 10^6)/4.334 + 44.0002 - 0.9820 = (4.3 \times 10^6)/47.3522 = 9.1 \times 10^4$

d. $(2.043 \times 10^{-2})^3 = 8.527 \times 10^{-6}$

56.

a. $(2.0944 + 0.0003233 + 12.22)/7.001 = (14.3147233)/7.001 = 2.045$

b. $(1.42 \times 10^2 + 1.021 \times 10^3)/(3.1 \times 10^{-1}) =$

$(142 + 1021)/(3.1 \times 10^{-1}) = (1163)/(3.1 \times 10^{-1}) = 3751 = 3.8 \times 10^3$

c. $(9.762 \times 10^{-3})/(1.43 \times 10^2 + 4.51 \times 10^1) =$

$(9.762 \times 10^{-3})/(143 + 45.1) = (9.762 \times 10^{-3})/(188.1) = 5.19 \times 10^{-5}$

d. $(6.1982 \times 10^{-4})^2 = (6.1982 \times 10^{-4})(6.1982 \times 10^{-4}) = 3.8418 \times 10^{-7}$

57. conversion factor

58. an infinite number (a definition)

59. $\dfrac{1\text{ mi}}{1760\text{ yd}}$ and $\dfrac{1760\text{ yd}}{1\text{ mi}}$

60. $\dfrac{1000\text{ mL}}{1\text{ L}}$ and $\dfrac{1\text{ L}}{1000\text{ mL}}$

61. $\dfrac{\$0.79}{1\text{ lb}}$

62. $\dfrac{1\text{ lb}}{\$0.79}$

63.

a. $32\text{ sec} \times \dfrac{1\text{ min}}{60\text{ sec}} = 0.53\text{ min}$

b. $2.4\text{ lb} \times \dfrac{1\text{ kg}}{2.205\text{ lb}} = 1.1\text{ kg}$

c. $2.4\text{ lb} \times \dfrac{453.59\text{ g}}{1\text{ lb}} = 1089\text{ g} = 1.1 \times 10^3\text{ g}$

d. $3150\text{ ft} \times \dfrac{1\text{ mi}}{5280\text{ ft}} = 0.597\text{ mi}$

e. $14.2\text{ in} \times \dfrac{1\text{ ft}}{12\text{ in}} = 1.18\text{ ft}$

f. $22.4\ \text{g} \times \dfrac{1\ \text{kg}}{1000\ \text{g}} = 0.0224\ \text{kg}$

g. $9.72\ \text{mg} \times \dfrac{1\ \text{g}}{1000\ \text{mg}} = 0.00972\ \text{g}$

h. $2.91\ \text{m} \times \dfrac{1.0936\ \text{yd}}{1\ \text{mi}} = 3.18\ \text{yd}$

64.

a. $2.23\ \text{m} \times \dfrac{1.094\ \text{yd}}{1\ \text{m}} = 2.44\ \text{yd}$

b. $46.2\ \text{yd} \times \dfrac{1\ \text{m}}{1.094\ \text{yd}} = 42.2\ \text{m}$

c. $292\ \text{cm} \times \dfrac{1\ \text{in}}{2.54\ \text{cm}} = 115\ \text{in}$

d. $881.2\ \text{in} \times \dfrac{2.54\ \text{cm}}{1\ \text{in}} = 2238\ \text{cm}$

e. $1043\ \text{km} \times \dfrac{1\ \text{mi}}{1.6093\ \text{km}} = 648.1\ \text{mi}$

f. $445.5\ \text{mi} \times \dfrac{1.6093\ \text{km}}{1\ \text{mi}} = 716.9\ \text{km}$

g. $36.2\ \text{m} \times \dfrac{1\ \text{km}}{1000\ \text{m}} = 0.0362\ \text{km}$

h. $0.501\ \text{km} \times \dfrac{1000\ \text{m}}{1\ \text{km}} \times \dfrac{100\ \text{cm}}{1\ \text{m}} = 5.01 \times 10^4\ \text{cm}$

65.

a. $17.3\ \text{L} \times \dfrac{1000\ \text{cm}^3}{1\ \text{L}} \times \left(\dfrac{1\ \text{in}}{2.54\ \text{cm}}\right)^3 \times \left(\dfrac{1\ \text{ft}}{12\ \text{in}}\right)^3 = 0.611\ \text{ft}^3$

b. $17.3\ \text{L} \times \dfrac{1000\ \text{mL}}{1\ \text{L}} = 1.73 \times 10^4\ \text{mL}$

c. c. $8.75\ \text{L} \times \dfrac{1\ \text{gal}}{3.7854\ \text{L}} = 2.31\ \text{gal}$

d. $762\ \text{g} \times \dfrac{16\ \text{oz}}{453.59\ \text{g}} = 26.9\ \text{oz}$

e. $1.00\ \text{g} \times \dfrac{1\ \text{kg}}{1000\ \text{g}} \times \dfrac{1\ \text{amu}}{1.66057 \times 10^{-27}\ \text{kg}} = 6.02 \times 10^{23}\ \text{amu}$

f. $1.00 \text{ L} \times \frac{1.057 \text{ qt}}{1 \text{ L}} \times \frac{2 \text{ pt}}{1 \text{ qt}} = 2.11 \text{ pt}$

g. $64.5 \text{ g} \times \frac{1 \text{ kg}}{1000 \text{ g}} = 0.0645 \text{ kg}$

h. $72.1 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} = 0.0721 \text{ L}$

66.

a. $5.25 \text{ oz} \times \frac{1 \text{ lb}}{16 \text{ oz}} = 0.328 \text{ lb}$

b. $125 \text{ g} \times \frac{1 \text{ lb}}{453.59 \text{ g}} = 0.276 \text{ lb}$

c. $125 \text{ g} \times \frac{1 \text{ lb}}{453.59 \text{ g}} \times \frac{16 \text{ oz}}{1 \text{ lb}} = 4.41 \text{ oz}$

d. $125 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} = 0.125 \text{ L}$

e. $125 \text{ mL} \times \frac{1.057 \text{ qt}}{1000 \text{ mL}} \times \frac{2 \text{ pt}}{1 \text{ qt}} = 0.264 \text{ pt}$

f. $2.5 \text{ mi} \times \frac{1.6093 \text{ km}}{1 \text{ mi}} = 4.0 \text{ km}$

g. $2.5 \text{ mi} \times \frac{1.6093 \text{ km}}{1 \text{ mi}} \times \frac{1000 \text{ m}}{1 \text{ km}} = 4.0 \times 10^3 \text{ m}$

h. $2.5 \text{ mi} \times \frac{1.6093 \text{ km}}{1 \text{ mi}} \times \frac{1000 \text{ m}}{1 \text{ km}} \times \frac{100 \text{ cm}}{1 \text{ m}} = 4.0 \times 10^5 \text{ cm}$

67. $1.00 \text{ Euro} \times \frac{\$1.00}{0.844 \text{ Euro}} = \$1.1848 = \$1.18$

68. $190 \text{ mi} = 1.9 \times 10^2 \text{ mi}$ to two significant figures

$1.9 \times 10^2 \text{ mi} \times \frac{1 \text{ km}}{0.62137 \text{ mi}} = 3.1 \times 10^2 \text{ km}$

$3.1 \times 10^2 \text{ km} \times \frac{1000 \text{ m}}{1 \text{ km}} = 3.1 \times 10^5 \text{ m}$

$1.9 \times 10^2 \text{ mi} \times \frac{5280 \text{ ft}}{1 \text{ mi}} = 1.0 \times 10^6 \text{ ft}$

69. To decide which train is faster, both speeds must be expressed in the *same unit* of distance (either miles or kilometers).

$$\frac{225 \text{ km}}{1 \text{ hr}} \times \frac{1 \text{ mi}}{1.6093 \text{ km}} = 140. \text{ mi/hr}$$

So the Boston-New York trains will be faster.

70. $1 \times 10^{-10} \text{ m} \times \frac{100 \text{ cm}}{1 \text{ m}} = 1 \times 10^{-8} \text{ cm}$

$$1 \times 10^{-8} \text{ cm} \times \frac{1 \text{ in}}{2.54 \text{ cm}} = 4 \times 10^{-9} \text{ in.}$$

$$1 \times 10^{-8} \text{ cm} \times \frac{1 \text{ m}}{100 \text{ cm}} \times \frac{10^{9} \text{ nm}}{1 \text{ m}} = 0.1 \text{ nm}$$

71. Celsius

72. freezing

73. 212°F; 100°C

74. 273

75. 100

76. Fahrenheit (F)

77. $T_K = T_C + 273$ $\qquad T_C = (T_F - 32)/1.80$

a. $22.5 + 273 = 295.5$ K

b. 444.9 K $- 273 = 171.9$°C

c. $0 + 273 = 273$ K

d. 298.1 K $- 273 = 25.1$°C

78. $T_C = T_K - 273$

a. $-210 + 273 = 63$ K

b. 275 K $- 273 = 2$°C

c. 778 K $- 273 = 505$°C

d. $778 + 273 = 1051$ K

79. $T_C = (T_F - 32)/1.80$

a. $(45 - 32)/1.80 = 13/1.80 = 7.2$°C

b. $(115 - 32)/1.80 = 83/1.80 = 46$°C

c. $(-10 - 32)/1.80 = -42/1.80 = -23$°C

d. Assuming 10,000°F to be known to two significant figures; $(10{,}000 - 32)/1.80 = 5500$°C

80. $T_F = 1.80(T_C) + 32$

a. $1.80(78.1) + 32 = 173°F$

b. $1.80(40.) + 32 = 104°F$

c. $1.80(-273) + 32 = -459°F$

d. $1.80(32) + 32 = 90.°F$

81. $T_F = 1.80(T_C) + 32$ $\quad T_C = (T_F - 32)/1.80$

a. $(25.1 - 32)/(1.80) = -3.8°C$

b. $1.80(25.1) + 32 = 77.2°F$

c. $25.1 - 273 = -247.9°C$

d. $25.1\text{ K} = -247.9°C$; $T_F = 1.80(-247.9) + 32 = -414°F$

82. $T_F = 1.80(T_C) + 32$ $\quad T_C = (T_F - 32)/1.80$

a. $275 - 273 = 2°C$

b. $(82 - 32)/1.80 = 28°C$

c. $1.80(-21) + 32 = -5.8°F$ ($-6°F$)

d. $(-40 - 32)/1.80 = -40\ °C$ (the Celsius and Fahrenheit temperatures are the same).

83. Density represents the mass per unit volume of a substance.

84. g/cm^3 (g/mL)

85. lead

86. 100 in^3

87. low; gases are mostly empty space, so there is less mass in a given volume than for solids and liquids.

88. Density is a *characteristic* property that is always the same for a pure substance.

89. Gold is the most dense; hydrogen is the least dense; 1 g of hydrogen would occupy the larger volume.

90. copper

91. $\text{density} = \dfrac{\text{mass}}{\text{volume}}$

a. $d = \dfrac{452.1\text{ g}}{292\text{ cm}^3} = 1.55\text{ g/cm}^3$

b. $m = 0.14\text{ lb} = 63.5\text{ g}$ $\quad v = 125\text{ mL} = 125\text{ cm}^3$

$d = \dfrac{63.5\text{ g}}{125\text{ cm}^3} = 0.51\text{ g/cm}^3$

c. $m = 1.01\text{ kg} = 1010\text{ g}$

$d = \dfrac{1010\text{ g}}{1000\text{ cm}^3} = 1.01\text{ g/cm}^3$

d. $m = 225 \text{ mg} = 0.225 \text{ g} \quad v = 2.51 \text{ mL} = 2.51 \text{ cm}^3$

$$d = \frac{0.225 \text{ g}}{2.51 \text{ cm}^3} = 0.0896 \text{ g/cm}^3$$

92. $\text{density} = \dfrac{\text{mass}}{\text{volume}}$

a. $d = \dfrac{122.4 \text{ g}}{5.5 \text{ cm}^3} = 22 \text{ g/cm}^3$

b. $v = 0.57 \text{ m}^3 \times \left(\dfrac{100 \text{ cm}}{1 \text{ m}}\right)^3 = 5.7 \times 10^5 \text{ cm}^3$

$$d = \frac{1.9302 \times 10^4 \text{ g}}{5.7 \times 10^5 \text{ cm}} = 0.034 \text{ g/cm}^3$$

c. $m = 0.0175 \text{ kg} \times \dfrac{1000 \text{ g}}{1 \text{ kg}} = 17.5 \text{ g}$

$$d = \frac{17.5 \text{ g}}{18.2 \text{ mL}} = 0.962 \text{ g/mL} = 0.962 \text{ g/cm}^3$$

d. $v = 0.12 \text{ m}^3 \times \left(\dfrac{100 \text{ cm}}{1 \text{ m}}\right)^3 = 1.2 \times 10^5 \text{ cm}^3$

$$d = \frac{2.49 \text{ g}}{1.2 \times 10^5 \text{ cm}^3} = 2.1 \times 10^{-5} \text{ g/cm}^3$$

93. $82.5 \text{ g} \times \dfrac{1 \text{ mL}}{0.785 \text{ g}} = 105 \text{ mL}$

94. $1.0 \text{ kg} = 1.0 \times 10^3 \text{ g}$

$1.0 \times 10^3 \text{ g} \times \dfrac{1 \text{ mL}}{1.097 \text{ g}} = 0.91 \text{ L}$ (two significant figures)

95. $d = \dfrac{784.6 \text{ g}}{1.00 \text{ L}} \times \dfrac{1.00 \text{ L}}{1000 \text{ mL}} = 0.785 \text{ g/mL}$ (three significant figures)

96. $m = 3.5 \text{ lb} \times \dfrac{453.59 \text{ g}}{1 \text{ lb}} = 1.59 \times 10^3 \text{ g}$

$v = 1.2 \times 10^4 \text{ in.}^3 \times \left(\dfrac{2.54 \text{ cm}}{1 \text{ in}}\right)^3 = 1.97 \times 10^5 \text{ cm}^3$

$$d = \frac{1.59 \times 10^3 \text{ g}}{1.97 \times 10^5 \text{ cm}^3} = 8.1 \times 10^{-3} \text{ g/cm}^3$$

The material will float.

97. The volume of the iron can be calculated from its mass and density;

$$v = 52.4 \text{ g} \times \frac{1 \text{ cm}^3}{7.87 \ g} = 6.66 \text{ cm}^3 = 6.66 \text{ mL}.$$

The liquid level in the graduated cylinder will rise by 6.66 mL when the cube of metal is added, giving a final volume of (75.0 + 6.66) = 81.7 mL.

98. $5.25 \text{ g} \times \frac{1 \text{ cm}^3}{10.5 g} = 0.500 \text{ cm}^3 = 0.500 \text{ mL}$

11.2 mL + 0.500 mL = 11.7 mL

99.

a. $50.0 \text{ g} \times \frac{1 \text{ cm}^3}{2.16 \ g} = 23.1 \text{ cm}^3$

b. $50.0 \text{ g} \times \frac{1 \text{ cm}^3}{13.6 \ g} = 3.68 \text{ cm}^3$

c. $50.0 \text{ g} \times \frac{1 \text{ cm}^3}{0.880 \ g} = 56.8 \text{ cm}^3$

d. $50.0 \text{ g} \times \frac{1 \text{ cm}^3}{10.5 \ g} = 4.76 \text{ cm}^3$

100.

a. $50.0 \text{ cm}^3 \times \frac{19.32 \text{ g}}{1 \text{ cm}^3} = 966 \text{ g}$

b. $50.0 \text{ cm}^3 \times \frac{7.87 \text{ g}}{1 \text{ cm}^3} = 394 \text{ g}$

c. $50.0 \text{ cm}^3 \times \frac{11.34 \text{ g}}{1 \text{ cm}^3} = 567 \text{ g}$

d. $50.0 \text{ cm}^3 \times \frac{2.70 \text{ g}}{1 \text{ cm}^3} = 135 \text{ g}$

101.

a. three

b. three

c. three

102.

a. $3.011 \times 10^{23} = 301{,}100{,}000{,}000{,}000{,}000{,}000{,}000$

b. $5.091 \times 10^{9} = 5{,}091{,}000{,}000$

c. $7.2 \times 10^{2} = 720$

d. $1.234 \times 10^5 = 123{,}400$

e. $4.32002 \times 10^{-4} = 0.000432002$

f. $3.001 \times 10^{-2} = 0.03001$

g. $2.9901 \times 10^{-7} = 0.00000029901$

h. $4.2 \times 10^{-1} = 0.42$

103.

a. 4.25×10^2

b. 7.81×10^{-4}

c. 2.68×10^4

d. 6.54×10^{-4}

e. 7.26×10^1

104.

a. centimeters

b. meters

c. kilometers

d. centimeters

e. millimeters

105.

a. $$1.25 \text{ in} \times \frac{1 \text{ ft}}{12 \text{ in}} = 0.104 \text{ ft}$$

$$1.25 \text{ in} \times \frac{2.54 \text{ cm}}{1 \text{ in}} = 3.18 \text{ cm}$$

b. $$2.12 \text{ qt} \times \frac{1 \text{ gal}}{4 \text{ qt}} = 0.530 \text{ gal}$$

$$2.12 \text{ qt} \times \frac{1 \text{ L}}{1.0567 \text{ qt}} = 2.01 \text{ L}$$

c. $$2640 \text{ ft} \times \frac{1 \text{ mi}}{5280 \text{ ft}} = 0.500 \text{ mi}$$

$$2640 \text{ ft} \times \frac{1.6093 \text{ km}}{5280. \text{ ft}} = 0.805 \text{ km}$$

d. $$1.254 \text{ kg} \times \frac{10^3 \text{ g}}{1 \text{ kg}} \times \frac{1 \text{ cm}^3}{11.34 \text{ g}} = 110.6 \text{ cm}^3$$

e. $250. \text{ mL} \times 0.785 \text{ g/mL} = 196 \text{ g}$

f. $3.5\ \text{in}^3 \times \left(\dfrac{2.54\ \text{cm}}{1\ \text{in}}\right)^3 = 57\ \text{cm}^3 = 57\ \text{mL}$

$57\ \text{cm}^3 \times 13.6\ \text{g/cm}^3 = 7.8 \times 10^2\ \text{g} = 0.78\ \text{kg}$

106.

a. $36.2\ \text{blim} \times \dfrac{1400\ \text{kryll}}{1\ \text{blim}} = 5.07 \times 10^4\ \text{kryll}$

b. $170\ \text{kryll} \times \dfrac{1\ \text{blim}}{1400\ \text{kryll}} = 0.12\ \text{blim}$

c. $72.5\ \text{kryll}^2 \times \left(\dfrac{1\ \text{blim}}{1400\ \text{kryll}}\right)^2 = 3.70 \times 10^{-5}\ \text{blim}^2$

107. $110\ \text{km} \times \dfrac{1\ \text{hr}}{100\ \text{km}} = 1.1\ \text{hr}$

108. $52\ \text{cm} \times \dfrac{1\ \text{in}}{2.54\ \text{cm}} = 20.\ \text{in}$

109. $45\ \text{mi} \times \dfrac{1.6093\ \text{km}}{1\ \text{mi}} = 72.4\ \text{km}$

$38\ \text{mi} \times \dfrac{1.6093\ \text{km}}{1\ \text{mi}} = 61.2\ \text{km}$

1 gal = 3.7854 L

highway; 72.4 km/3.7854 L = 19 km/L

city; 61.2 km/3.7854 L = 16 km/L

110. $1\ \text{lb} \times \dfrac{1\ \text{kg}}{2.2\ \text{lb}} \times \dfrac{\$1.20}{1\ \text{euro}} \times \dfrac{2.45\ \text{euro}}{1\ \text{kg}} = \ = \$1.33\ \text{per pound}$

111. $15.6\ \text{g} \times \dfrac{1\ \text{capsule}}{0.65\ \text{g}} = 24\ \text{capsules}$

112. $°\text{X} = 1.26°\text{C} + 14$

113. $v = \frac{4}{3}(\pi r^3) = \ \frac{4}{3}(3.1416)(0.5\ \text{cm})^3 = 0.52\ \text{cm}^3$

$d = \dfrac{2.0\ \text{g}}{0.52\ \text{cm}^3} = 3.8\ \text{g/cm}^3$ (the ball will sink)

114. $d = \dfrac{36.8\ \text{g}}{10.5\ \text{L}} = 3.50\ \text{g/L}$ $(3.50 \times 10^{-3}\ \text{g/cm}^3)$

115.

a. $25.0\ \text{g} \times \dfrac{1\ \text{cm}^3}{0.000084\ g} = 2.98 \times 10^5\ \text{cm}^3$

b. $25.0\ g \times \frac{1\ cm^3}{13.6\ g} = 1.84\ cm^3$

c. $25.0\ g \times \frac{1\ cm^3}{11.34\ g} = 2.20\ cm^3$

d. $25.0\ g \times \frac{1\ cm^3}{1.00\ g} = 25.0\ cm^3$

116. For ethanol, $100.\ mL \times \frac{0.785\ g}{1\ mL} = 78.5\ g$

For benzene, $1000\ mL \times \frac{0.880\ g}{1\ mL} = 880.\ g$

total mass, 78.5 + 880. = 959 g

117. three

118.

a. negative
b. negative
c. positive
d. zero
e. negative

119.

a. positive
b. negative
c. negative
d. zero

120.

a. 2; positive
b. 11; negative
c. 3; positive
d. 5; negative
e. 5; positive
f. 0; zero
g. 1; negative
h. 7; negative

121.

a. 4; positive
b. 6; negative

c. 0; zero
d. 5; positive
e. 2; negative

122.

a. 1; positive
b. 3; negative
c. 0; zero
d. 3; positive
e. 9; negative

123.

a. The decimal point must be moved two places to the left, so the exponent is positive two; 529 = 5.29×10^2.
b. The decimal point must be moved eight places to the left, so the exponent is positive eight; 240,000,000 = 2.4×10^8.
c. The decimal point must be moved 17 places to the left, so the exponent is positive 17; 301,000,000,000,000,000 = 3.01×10^{17}.
d. The decimal point must be moved four places to the left, so the exponent is positive four; 78,444 = 7.8444×10^4.
e. The decimal point must be moved four places to the right, so the exponent is negative four; 0.0003442 = 3.442×10^{-4}.
f. The decimal point must be moved ten places to the right, so the exponent is negative ten; 0.000000000902 = 9.02×10^{-10}.
g. The decimal point must be moved two places to the right, so the exponent is negative two; 0.043 = 4.3×10^{-2}.
h. The decimal point must be moved two places to the right, so the exponent is negative two; 0.0821 = 8.21×10^{-2}.

124.

a. The decimal point must be moved five places to the left; 2.98×10^{-5} = 0.0000298.
b. The decimal point must be moved nine places to the right; 4.358×10^9 = 4,358,000,000.
c. The decimal point must be moved six places to the left; 1.9928×10^{-6} = 0.0000019928.
d. The decimal point must be moved 23 places to the right; 6.02×10^{23} = 602,000,000,000,000,000,000,000.
e. The decimal point must be moved one place to the left; 1.01×10^{-1} = 0.101.
f. The decimal point must be moved three places to the left; 7.87×10^{-3} = 0.00787.
g. The decimal point must be moved seven places to the right; 9.87×10^7 = 98,700,000.
h. The decimal point must be moved two places to the right; 3.7899×10^2 = 378.99.
i. The decimal point must be moved one place to the left; 1.093×10^{-1} = 0.1093.

j. The decimal point must be moved zero places; $2.9004 \times 10^0 = 2.9004$.

k. The decimal point must be moved four places to the left; $3.9 \times 10^{-4} = 0.00039$.

l. The decimal point must be moved eight places to the left; $1.904 \times 10^{-8} = 0.00000001904$.

125. To say that scientific notation is in *standard* form means that you have a number between one and ten, followed by an exponential term. The numbers given in this problem are *not* between one and ten as written.

a. $102.3 \times 10^{-5} = (1.023 \times 10^2) \times 10^{-5} = 1.023 \times 10^{-3}$

b. $32.03 \times 10^{-3} = (3.203 \times 10^1) \times 10^{-3} = 3.203 \times 10^{-2}$

c. $59933 \times 10^2 = (5.9933 \times 10^4) \times 10^2 = 5.9933 \times 10^6$

d. $599.33 \times 10^4 = (5.9933 \times 10^2) \times 10^4 = 5.9933 \times 10^6$

e. $5993.3 \times 10^3 = (5.9933 \times 10^3) \times 10^3 = 5.9933 \times 10^6$

f. $2054 \times 10^{-1} = (2.054 \times 10^3) \times 10^{-1} = 2.054 \times 10^2$

g. $32{,}000{,}000 \times 10^{-6} = (3.2 \times 10^7) \times 10^{-6} = 3.2 \times 10^1$

h. $59.933 \times 10^5 = (5.9933 \times 10^1) \times 10^5 = 5.9933 \times 10^6$

126.

a. $1/10^2 = 1 \times 10^{-2}$

b. $1/10^{-2} = 1 \times 10^2$

c. $55/10^3 = \dfrac{5.5 \times 10^1}{1 \times 10^3} = 5.5 \times 10^{-2}$

d. $(3.1 \times 10^6)/10^{-3} = \dfrac{3.1 \times 10^6}{1 \times 10^{-3}} = 3.1 \times 10^9$

e. $(10^6)^{1/2} = 1 \times 10^3$

f. $(10^6)(10^4)/(10^2) = \dfrac{(1 \times 10^6)(1 \times 10^4)}{(1 \times 10^2)} = 1 \times 10^8$

g. $1/0.0034 = \dfrac{1}{3.4 \times 10^{-3}} = 2.9 \times 10^2$

h. $3.453/10^{-4} = \dfrac{3.453}{1 \times 10^{-4}} = 3.453 \times 10^4$

127. meter

128. Kelvin, K

129. 100 km (See inside cover of textbook.)

130. centimeter

131. 250. mL

132. 0.105 m

133. 100 km/hr = 62.1 mi/hr. You would not violate the speed limit.

134. 1 kg (100 g = 0.1 kg)

135. 4.25 g (425 mg = 0.425 g)

136. 10 cm (1 cm = 10 mm)

137. significant figures (digits)

138. 2.8 (the hundredths place is estimated)

139.

a. one

b. one

c. four

d. two

e. infinite (definition)

f. one

140.

a. 0.000426

b. 4.02×10^{-5}

c. 5.99×10^{6}

d. 400.

e. 0.00600

141.

a. 0.7556

b. 293

c. 17.01

d. 432.97

142.

a. 2149.6 (The answer can be given only to the first decimal place because 149.2 is known only to the first decimal place)

b. 5.37×10^{3} (The answer can be given only to two decimal places because 4.34 is known only to two decimal places. Moreover, since the power of ten is the same for each number, the calculation can be performed directly.)

c. Before performing the calculation, the numbers have to be converted so that they contain the same power of ten.

$4.03 \times 10^{-2} - 2.044 \times 10^{-3} = 4.03 \times 10^{-2} - 0.2044 \times 10^{-2} = 3.83 \times 10^{-2}$ (The answer can be given only to the second decimal place because 4.03×10^{-2} is known only to the second decimal place.)

d. Before performing the calculation, the numbers have to be converted so that they contain the same power of ten.

$2.094 \times 10^{5} - 1.073 \times 10^{6} = 2.094 \times 10^{5} - 10.73 \times 10^{5} = -8.64 \times 10^{5}$

143.

a. 5.57×10^7 (The answer can be given only to three significant figures because 0.0432 and 4.43×10^8 are known only to three significant figures.)

b. 2.38×10^{-1} (The answer can be given only to three significant figures because 0.00932 and 4.03×10^2 are known only to three significant figures.)

c. 4.72 (The answer can be given only to three significant figures because 2.94 is known only to three significant figures.)

d. 8.08×10^8 (The answer can be given only to three significant figures because 0.000934 is known only to three significant figures.)

144.

a. $(2.9932 \times 10^4)(2.4443 \times 10^2 + 1.0032 \times 10^1) =$

$(2.9932 \times 10^4)(24.443 \times 10^1 + 1.0032 \times 10^1) =$

$(2.9932 \times 10^4)(25.446 \times 10^1) = 7.6166 \times 10^6$

b. $(2.34 \times 10^2 + 2.443 \times 10^{-1})/(0.0323) =$

$(2.34 \times 10^2 + 0.002443 \times 10^2)/(0.0323) =$

$(2.34 \times 10^2)/(0.0323) = 7.24 \times 10^3$

c. $(4.38 \times 10^{-3})^2 = 1.92 \times 10^{-5}$

d. $(5.9938 \times 10^{-6})^{1/2} = 2.4482 \times 10^{-3}$

145. $\frac{1\text{ L}}{1000\text{ cm}^3}$; $\frac{1000\text{ cm}^3}{1\text{ L}}$

146. $\frac{1\text{ year}}{12\text{ months}}$; $\frac{12\text{ months}}{1\text{ year}}$

147.

a. $8.43\text{ cm} \times \frac{10\text{ mm}}{1\text{ cm}} = 84.3\text{ mm}$

b. $2.41 \times 10^2\text{ cm} \times \frac{1\text{ m}}{100\text{ cm}} = 2.41\text{ m}$

c. $294.5\text{ nm} \times \frac{1\text{ m}}{10^9\text{ nm}} \times \frac{100\text{ cm}}{1\text{ m}} = 2.945 \times 10^{-5}\text{ cm}$

d. $404.5\text{ m} \times \frac{1\text{ km}}{1000\text{ m}} = 0.4045\text{ km}$

e. $1.445 \times 10^4\text{ m} \times \frac{1\text{ km}}{1000\text{ m}} = 14.45\text{ km}$

f. $42.2\text{ mm} \times \frac{1\text{ cm}}{10\text{ mm}} = 4.22\text{ cm}$

g. $235.3\text{ m} \times \dfrac{1000\text{ mm}}{1\text{ m}} = 2.353 \times 10^5\text{ mm}$

h. $903.3\text{ nm} \times \dfrac{1\text{ m}}{10^9\text{ nm}} \times \dfrac{10^6\ \mu\text{m}}{1\text{m}} = 0.9033\ \mu\text{m}$

148.

a. $908\text{ oz} \times \dfrac{1\text{ lb}}{16\text{ oz}} \times \dfrac{1\text{ kg}}{2.2046\text{ lb}} = 25.7\text{ kg}$

b. $12.8\text{ L} \times \dfrac{1\text{ qt}}{0.94633\text{ L}} \times \dfrac{1\text{ gal}}{4\text{ qt}} = 3.38\text{ gal}$

c. $125\text{ mL} \times \dfrac{1\text{ L}}{1000\text{ mL}} \times \dfrac{1\text{ qt}}{0.94633\text{ L}} = 0.132\text{ qt}$

d. $2.89\text{ gal} \times \dfrac{4\text{ qt}}{1\text{ gal}} \times \dfrac{1\text{ L}}{1.0567\text{ qt}} \times \dfrac{1000\text{ mL}}{1\text{ L}} = 1.09 \times 10^4\text{ mL}$

e. $4.48\text{ lb} \times \dfrac{453.59\text{ g}}{1\text{ lb}} = 2.03 \times 10^3\text{ g}$

f. $550\text{ mL} \times \dfrac{1\text{ L}}{1000\text{ mL}} \times \dfrac{1.0567\text{ qt}}{1\text{ L}} = 0.58\text{ qt}$

149. $9.3 \times 10^7\text{ mi} \times \dfrac{1\text{ km}}{0.62137\text{ mi}} = 1.5 \times 10^8\text{ km}$

$1.5 \times 10^8\text{ km} \times \dfrac{1000\text{ m}}{1\text{ km}} \times \dfrac{100\text{ cm}}{1\text{ m}} = 1.5 \times 10^{13}\text{ cm}$

150. Assuming exactly 6 gross, 864 pencils

151. $T_K = T_C + 273$

a. $0 + 273 = 273\text{ K}$

b. $25 + 273 = 298\text{ K}$

c. $37 + 273 = 310.\text{ K}$

d. $100 + 273 = 373\text{ K}$

e. $-175 + 273 = 98\text{ K}$

f. $212 + 273 = 485\text{ K}$

152.

a. Celsius temperature = $(175 - 32)/1.80 = 79.4°\text{C}$

Kelvin temperature = $79.4 + 273 = 352\text{ K}$

b. $255 - 273 = -18\ °\text{C}$

c. $(-45 - 32)/1.80 = -43°\text{C}$

d. $1.80(125) + 32 = 257°\text{F}$

153. $\text{density} = \dfrac{\text{mass}}{\text{volume}}$

a. $d = \dfrac{234\ \text{g}}{2.2\ \text{cm}^3} = 110\ \text{g/cm}^3$

b. $m = 2.34\ \text{kg} \times \dfrac{1000\ \text{g}}{1\ \text{kg}} = 2340\ \text{g}$

$v = 2.2\ \text{m}^3 \times \left(\dfrac{100\ \text{cm}}{1\ \text{m}}\right)^3 = 2.2 \times 10^6\ \text{cm}^3$

$d = \dfrac{2340\ \text{g}}{2.2 \times 10^6\ \text{cm}^3} = 1.1 \times 10^{-3}\ \text{g/cm}^3$

c. $m = 1.2\ \text{lb} \times \dfrac{453.59\ \text{g}}{1\ \text{lb}} = 544\ \text{g}$

$v = 2.1\ \text{ft}^3 \times \left(\dfrac{12\ \text{in}}{1\ \text{ft}}\right)^3 \times \left(\dfrac{2.54\ \text{cm}}{1\ \text{in}}\right)^3 = 5.95 \times 10^4\ \text{cm}^3$

$d = \dfrac{544\ \text{g}}{5.95 \times 10^4\ \text{cm}^3} = 9.1 \times 10^{-3}\ \text{g/cm}^3$

d. $m = 4.3\ \text{ton} \times \dfrac{2000\ \text{lb}}{1\ \text{ton}} \times \dfrac{453.59\ \text{g}}{1\ \text{lb}} = 3.90 \times 10^6\ \text{g}$

$v = 54.2\ \text{yd}^3 \times \left(\dfrac{1\ \text{m}}{1.0936\ \text{yd}}\right)^3 \times \left(\dfrac{100\ \text{cm}}{1\ \text{m}}\right)^3 = 4.14 \times 10^7\ \text{cm}^3$

$d = \dfrac{3.90 \times 10^6\ \text{g}}{4.14 \times 10^7\ \text{cm}^3} = 9.4 \times 10^{-2}\ \text{g/cm}^3$

154. $85.5\ \text{mL} \times \dfrac{0.915\ \text{g}}{1\ \text{mL}} = 78.2\ \text{g}$

155. $50.0\ \text{g} \times \dfrac{1\ \text{mL}}{1.31\ \text{g}} = 38.2\ \text{g}$

156. $m = 155\ \text{lb} \times \dfrac{453.59\ \text{g}}{1\ \text{lb}} = 7.031 \times 10^4\ \text{g}$

$v = 4.2\ \text{ft}^3 \times \left(\dfrac{12\ \text{in}}{1\ \text{ft}}\right)^3 \times \left(\dfrac{2.54\ \text{cm}}{1\ \text{in}}\right)^3 = 1.189 \times 10^5\ \text{cm}^3$

$d = \dfrac{7.031 \times 10^4\ \text{g}}{1.189 \times 10^5\ \text{cm}^3} = 0.59\ \text{g/cm}^3$

157. Volume = 21.6 mL – 12.7 mL = 8.9 mL

$d = \dfrac{33.42\ \text{g}}{8.9\ \text{mL}} = 3.8\ \text{g/mL}$

158. $T_F = 1.80(T_C) + 32$

a. 23 °F

b. 32 °F

c. –321 °F

d. –459 °F

e. 187 °F

f. –459 °F