Measurements in Chemistry — Chapter 2

Problem-Set Solutions

2.1 It is easier to use because it is a decimal unit system.

2.2 Common measurements include mass, volume, length, time, temperature, pressure, and concentration.

2.3 a. The metric prefix *giga,* abbreviated as G, has a value of 10^9.
b. The metric prefix *nano,* abbreviated as n, has a value of 10^{-9}.
c. The metric prefix *mega,* abbreviated as M, has a value of 10^6.
d. The metric prefix *micro,* abbreviated as μ, has a value of 10^{-6}.

2.4 a. kilo-, 10^3 b. M, 10^6 c. pico-, p d. d, 10^{-1}

2.5 a. A kilogram, abbreviated as kg, measures mass.
b. A megameter, abbreviated as Mm, measures length.
c. A nanogram, abbreviated as ng, measures mass.
d. A milliliter, abbreviated as mL, measures volume.

2.6 a. centimeter, length b. volume, dL c. picometer, length d. mass, kg

2.7 The meaning of a metric system prefix is independent of the base unit it modifies. The lists, arranged from smallest to largest are:
a. nanogram, milligram, centigram
b. kilometer, megameter, gigameter
c. picoliter, microliter, deciliter
d. microgram, milligram, kilogram

2.8 a. microliter, milliliter, gigaliter
b. centigram, decigram, megagram
c. picometer, micrometer, kilometer
d. nanoliter, milliliter, centiliter

2.9 a. Measure the thickness of a chemistry textbook in <u>centimeters</u>.
b. Measure the mass of a cantaloupe seed in <u>milligrams</u>.
c. Measure the capacity of a car's gasoline tank in <u>liters</u>.
d. Measure the length of a man's tie in <u>decimeters</u>.

2.10 a. centimeter b. meter c. milliliter d. kilogram

2.11 60 minutes is a counted (exact number), and 60 feet is a measured (inexact) number.

2.12 27 people is a counted (exact number), and 27 miles per hour is a measured (inexact) number.

2.13 An exact number has no uncertainty associated with it; an inexact number has a degree of uncertainty. Whenever defining a quantity or counting, the resulting number is exact. Whenever a measurement is made, the resulting number is inexact.
a. 32 is an exact number of chairs.
b. 60 is an exact number of seconds.
c. 3.2 pounds is an inexact measure of weight.
d. 323 is an exact number of words.

2.14 a. exact b. inexact c. inexact d. exact

2.15 Measurement results in an inexact number; counting and definition result in exact numbers.
a. The length of a swimming pool is an inexact number because it is measured.
b. The number of gummi bears in a bag is an exact number; gummi bears are counted.
c. The number of quarts in a gallon is exact because it is a defined number.
d. The surface area of a living room rug is an inexact number because it is calculated from two inexact measurements of length.

2.16 a. exact b. exact c. inexact d. inexact

2.17 The last digit of a measurement is estimated.
a. The estimated digit is the 4. b. The estimated digit is the zero.
c. The estimated digit is the 4. d. The estimated digit is the 4.

2.18 a. the 7 b. the zero c. the zero d. the 7

2.19 The magnitude of the uncertainty is indicated by a 1 in the last measured digit.
a. The magnitude of the uncertainty is ±1
b. The magnitude of the uncertainty is ±0.1
c. The magnitude of the uncertainty is ±0.001
d. The magnitude of the uncertainty is ±0.00001

2.20 a. 1 b. 0.1 c. 0.001 d. 0.0001

2.21 Only one estimated digit is recorded as part of a measurement.
a. Temperature recorded using a thermometer marked in degrees should be recorded to 0.1 degree.
b. The volume from a graduated cylinder with markings of tenths of milliliters should be recorded to 0.01 mL.
c. Volume using a volumetric device with markings every 10 mL should be recorded to 1 mL.
d. Length using a ruler with a smallest scale marking of 1 mm should be recorded to 0.1 mm.

2.22 a. 0.1 cm b. 0.1° c. 0.01°F d. 1 mL

2.23 a. 0.1 cm; since the ruler is marked in ones units, the estimated digit is tenths
b. 0.1 cm; since the ruler is marked in ones units, the estimated digit is tenths

2.24 a. 0.01 cm; since the ruler is marked in tenths units, the estimated digit is hundredths
b. 1 cm; since the ruler is marked in tens units, the estimated digit is ones

2.25 a. 2.70 cm; the value is very close to 2.7, with the estimated value being 2.70
b. 27 cm; the value is definitely between 20 and 30, with the estimated value being 27

2.26 a. 2.7 cm; the value is definitely between 2 and 3, with the estimated value being 2.7
b. 27.0 cm; the value is very close to 27, with the estimated value being 27.0

2.27 a. ruler 4; since the ruler is marked in ones units it can be read to tenths
b. ruler 1 or 4; since both rulers are marked in ones units they can be read to tenths
c. ruler 2; since the ruler is marked in tenths units it can be read to hundredths
d. ruler 3; since the ruler is marked in tens units it can be read to ones

2.28 a. ruler 1 or 4; since both rulers are marked in ones units they can be read to tenths
b. ruler 2; since the ruler is marked in tenths units it can be read to hundredths
c. ruler 3; since the ruler is marked in tens units it can be read to ones
d. ruler 3; since the ruler is marked in tens units it can be read to ones

2.29 Significant figures are the digits in a measurement that are known with certainty plus one digit that is uncertain. In a measurement, all nonzero numbers, and some zeros, are significant.
a. 0.444 has three significant figures.
b. 0.00444 has three significant figures.
c. 0.04040 has four significant figures.
d. 0.00004 has one significant figure.

2.30 a. 3 b. 3 c. 5 d. 5

2.31 a. 275.00 has 5 significant figures. Trailing zeros are significant when a decimal point is present.
b. 27,500 has 3 significant figures. Trailing zeros are not significant if the number lacks an explicit decimal point. .
c. 6,720,000 has 3 significant figures. Trailing zeros are not significant if the number lacks an explicit decimal point.
d. 6,720,100 has 5 significant figures. Trailing zeros are not significant if the number lacks an explicit decimal point. Confined zeros are significant

2.32 a. 5 b. 3 c. 4 d. 6

2.33 a. 11.01 and 11.00 have the same number (four) of significant figures. All of the zeros are significant because they are either confined or trailing with an explicit decimal point.
b. 2002 has four significant figures, and 2020 has three. The last zero in 2020 is not significant because there is no explicit decimal point.
c. 0.000066 and 660,000 have the same number (two) of significant figures. None of the zeros in either number are significant because they are either leading zeros or trailing zeros with no explicit decimal point.
d. 0.05700 and 0.05070 have the same number (four) of significant figures. The trailing zeros are significant because there is an explicit decimal point.

2.34 a. different b. different c. different d. same

2.35 a. Yes, 11.01 and 11.00 have the same uncertainty.
b. No, 2002 and 2020 do not have the same uncertainty.
c. No, 0.000066 and 660,000 do not have the same uncertainty.
d. Yes, 0.05700 and 0.05070 have the same uncertainty.

2.36 a. no b. no c. no d. no

2.37 a. For 5371: number of significant figures is 4; estimated digit is 1; uncertainty is ±1.
b. For 0.41: number of significant figures is 2; estimated digit is 1; uncertainty is ±0.01.
c. For 3200: number of significant figures is 2; estimated digit is 2; uncertainty is ±100.
d. For 5050: number of significant figures is 3; estimated digit is last 5; uncertainty is ±10.

2.38 a. 2, the last 0, ±0.001
b. 2, the 1, ±100
c. 4, the 5, ±1
d. 3, the 3, ±0.01

2.39 The estimated number of people is 50,000.
- a. If the uncertainty is 10,000, the low and high estimates are 40,000 to 60,000.
- b. If the uncertainty is 1000, the low and high estimates are 49,000 to 51,000.
- c. If the uncertainty is 100, the low and high estimates are 49,900 to 50,100.
- d. If the uncertainty is 10, the low and high estimates are 49,990 to 50,010.

2.40 a. 30,000-50,000 b. 39,000-41,000 c. 39,900-40,100 d. 39,990-40,010

2.41 When rounding numbers, if the first digit to be deleted is 4 or less, drop it and the following digits; if it is 5 or greater, drop that digit and all of the following digits and increase the last retained digit by one.
- a. 0.350763 to four s.f. is 0.3508
- b. 13.43 to three s.f. is 13.4
- c. 22.4555 to two s.f. is 22
- d. 0.030303 to three s.f. is 0.0303

2.42 a. 340.3 b. 133 c. 0.045 d. 0.357

2.43 To obtain a number with three significant figures:
- a. 3567 becomes 3570
- b. 323,200 becomes 323,000
- c. 18 becomes 18.0
- d. 2,345,346 becomes 2,350,000

2.44 a. 1230 b. 25,700 c. 7.20 d. 3,670,000

2.45 Rounding:
- a. 1.8828: to four significant figures is 1.883; to two significant figures is 1.9
- b. 24,233: to four significant figures is 24,230; to two significant figures is 24,000
- c. 0.51181: to four significant figures is 0.5118; to two significant figures is 0.51
- d. 7.4500: to four significant figures is 7.450; to two significant figures is 7.5

2.46 a. 0.5373; 0.54 b. 34.41; 34 c. 25,550; 26,000 d. 7.101; 7.1

2.47 In multiplication and division, the number of significant figures in the answer is the same as the number of significant figures in the measurement that contains the fewest significant figures. (s.f. stands for significant figures)
- a. 10,300 (three s.f.) × 0.30 (two s.f.) × 0.300 (three s.f.) Since the least number of significant figures is two, the answer will have two significant figures.
- b. 3300 (two s.f.) × 3330 (three s.f.) × 333.0 (four s.f.) The lowest number of significant figures is two, so the answer will have two significant figures.
- c. 6.0 (two s.f.) ÷ 33.0 (three s.f.) The answer will have two significant figures.
- d. 6.000 (four s.f.) ÷ 33 (two s.f.) The answer will have two significant figures.

2.48 a. 1 b. 1 c. 2 d. 1

2.49 In multiplication and division of measured numbers, the answer has the same number of significant figures as the measurement with the fewest significant figures. (s.f. stands for significant figures.)
- a. 2.0000 (five s.f.) × 2.00 (three s.f.) × 0.0020 (two s.f.) = 0.0080 (two s.f.)
- b. 4.1567 (five s.f.) × 0.00345 (three s.f.) = 0.0143 (three s.f.)
- c. 0.0037 (two s.f.) × 3700 (two s.f.) × 1.001 (four s.f.) = 14 (two s.f.)
- d. 6.00 (three s.f.) ÷ 33.0 (three s.f.) = 0.182 (three s.f.)
- e. 530,000 (two s.f.) ÷ 465,300 (four s.f.) = 1.1 (two s.f.)
- f. 4670 (four s.f.) × 3.00 (three s.f.) ÷ 2.450 (four s.f.) = 5720 (three s.f.)

2.50 a. 0.080 b. 0.1655 c. 0.0048 d. 0.1818 e. 36,000 f. 1.44

2.51 In addition and subtraction of measured numbers, the answer has no more digits to the right of the decimal point than are found in the measurement with the fewest digits to the right of the decimal point.
a. 12 + 23 + 127 = 162 (no digits to the right of the inferred decimal point)
b. 3.111 + 3.11 + 3.1 = 9.3 (one digit to the right of the decimal point)
c. 1237.6 + 23 + 0.12 = 1261 (no digits to the right of the inferred decimal point)
d. 43.65 – 23.7 = 20.0 (one digit to the right of the decimal point)

2.52 a. 281 b. 12.20 c. 309 d. 1.04

2.53 a. The uncertainty of 12.37050 rounded to 6 significant figures is 0.0001
b. The uncertainty of 12.37050 rounded to 4 significant figures is 0.01
c. The uncertainty of 12.37050 rounded to 3 significant figures is 0.1
d. The uncertainty of 12.37050 rounded to 2 significant figures is 1

2.54 a. 0.0001 b. 0.001 c. 0.01 d. 1

2.55 Scientific notation is a numerical system in which a decimal number is expressed as the product of a number between 1 and 10 (the coefficient) and 10 raised to a power (the exponential term). To convert a number from decimal notation to scientific notation, move the decimal point to a position behind the first nonzero digit. The exponent in the exponential term is equal to the number of places the decimal point was moved.
a. 0.0123 expressed in scientific notation is 1.23×10^{-2}. Negative exponent.
b. 375,000 expressed in scientific notation is 3.75×10^{5}. Positive exponent.
c. 0.100 expressed in scientific notation is 1.00×10^{-1}. Negative exponent.
d. 68.75 expressed in scientific notation is 6.875×10^{1}. Positive exponent.

2.56 a. positive b. positive c. negative d. positive

2.57 To convert a number from decimal notation to scientific notation, move the decimal point to a position behind the first nonzero digit. The exponent in the exponential term is equal to the number of places the decimal point was moved.
a. For 0.0123 move the decimal 2 places to the right.
b. For 375,000 move the decimal 5 places to the left.
c. For 0.100 move the decimal 1 place to the right.
d. For 68.75 move the decimal 1 place to the left.

2.58 a. 1 b. 5 c. 1 d. 2

2.59 In scientific notation, only significant figures become part of the coefficient.
a. For 0.0123 there will be 3 significant figures in the scientific notation.
b. For 375,000 there will be 3 significant figures in the scientific notation.
c. For 0.100 there will be 3 significant figures in the scientific notation.
d. For 68.75 there will be 4 significant figures in the scientific notation.

2.60 a. 5 b. 5 c. 4 d. 3

2.61 To convert a number from decimal notation to scientific notation, move the decimal point to a position behind the first nonzero digit. The exponent in the exponential term is equal to the number of places the decimal point was moved.

a. 120.7 expressed in scientific notation is 1.207×10^2
b. 0.0034 expressed in scientific notation is 3.4×10^{-3}
c. 231.00 expressed in scientific notation is 2.3100×10^2
d. 23,100 expressed in scientific notation is 2.31×10^4

2.62 a. 3.722×10^1 b. 1.02×10^{-3} c. 3.4000×10^1 d. 2.34×10^5

2.63 To convert a number from scientific notation to decimal notation, move the decimal point in the coefficient to the right for a positive exponent or to the left for a negative exponent. The number of places the decimal point is moved is specified by the exponent.

a. 2.34×10^2 expressed in decimal notation is 234
b. 2.3400×10^2 expressed in decimal notation is 234.00
c. 2.34×10^{-3} expressed in decimal notation is 0.00234
d. 2.3400×10^{-3} expressed in decimal notation is 0.0023400

2.64 a. 3721 b. 372.10 c. 0.0676 d. 0.067600

2.65 To multiply numbers expressed in scientific notation, multiply the coefficients and add the exponents in the exponential terms. To divide numbers expressed in scientific notation, divide the coefficients and subtract the exponents.

a. $(3.20 \times 10^7) \times (1.720 \times 10^5) = 5.504 \times 10^{12} = 5.50 \times 10^{12}$ The coefficient in the answer is expressed to three significant figures because one of the numbers being multiplied has only three significant figures.
b. $(1.00 \times 10^3) \times (5.00 \times 10^3) \times (3.0 \times 10^{-3}) = 15 \times 10^3 = 1.5 \times 10^4$ To express the answer in correct scientific notation, the decimal point in the coefficient was moved one place to the left, and the exponent was increased by 1.
c. $(3.0 \times 10^{-5}) \div (1.5 \times 10^2) = 2.0 \times 10^{-7}$
d. $(2.2 \times 10^6) \times (2.3 \times 10^{-6}) \div (1.2 \times 10^{-3}) \div (3.5 \times 10^{-3}) = 1.2 \times 10^6$

2.66 a. 5.3×10^{12} b. 8.1×10^{-2} c. 2.0×10^{-8} d. 1.3×10^5

2.67 a. 10^2; the uncertainty in the coefficient is 10^{-2} and multiplying this by the power of ten gives $10^{-2} \times 10^4 = 10^2$
b. 10^4; $10^{-2} \times 10^6 = 10^4$
c. 10^4; $10^{-1} \times 10^5 = 10^4$
d. 10^{-4}; $10^{-1} \times 10^{-3} = 10^{-4}$

2.68 a. 10^{-4}; the uncertainty in the coefficient is 10^{-2} and multiplying this by the power of ten gives $10^{-2} \times 10^{-2} = 10^{-4}$
b. 10^{-4}; $10^{-3} \times 10^{-1} = 10^{-4}$
c. 10^2; $10^{-1} \times 10^3 = 10^2$
d. 10^2; $10^{-3} \times 10^5 = 10^2$

2.69 To convert a number from decimal notation to scientific notation, move the decimal point to a position behind the first nonzero digit. The exponent in the exponential term is equal to the number of places the decimal point was moved.

a. 0.00300300 to three significant figures becomes 3.00×10^{-3}
b. 936,000 to two significant figures becomes 9.4×10^{5}
c. 23.5003 to three significant figures becomes 2.35×10^{1}
d. 450,000,001 to six significant figures becomes 4.50000×10^{8}

2.70 a. 3.030×10^{-1} b. 1.51×10^{1} c. 3.26×10^{6} d. 3.200×10^{7}

2.71 Conversion factors are derived from equations (equalities) that relate units. They always come in pairs, one member of the pair being the reciprocal of the other.

a. 1 day = 24 hours The conversion factors derived from this equality are:

$$\frac{1\text{ day}}{24\text{ hours}} \text{ or } \frac{24\text{ hours}}{1\text{ day}}$$

b. 1 century = 10 decades The conversion factors derived from this equality are:

$$\frac{1\text{ century}}{10\text{ decades}} \text{ or } \frac{10\text{ decades}}{1\text{ century}}$$

c. 1 yard = 3 feet The conversion factors derived from this equality are:

$$\frac{1\text{ yard}}{3\text{ feet}} \text{ or } \frac{3\text{ feet}}{1\text{ yard}}$$

d. 1 gallon = 4 quarts The conversion factors derived from this equality are:

$$\frac{1\text{ gallon}}{4\text{ quarts}} \text{ or } \frac{4\text{ quarts}}{1\text{ gallon}}$$

2.72 a. $\frac{1\text{ week}}{7\text{ days}}$ or $\frac{7\text{ days}}{1\text{ week}}$ b. $\frac{1\text{ century}}{100\text{ years}}$ or $\frac{100\text{ years}}{1\text{ century}}$

c. $\frac{1\text{ foot}}{12\text{ inches}}$ or $\frac{12\text{ inches}}{1\text{ foot}}$ d. $\frac{2\text{ pints}}{1\text{ quart}}$ or $\frac{1\text{ quart}}{2\text{ pints}}$

2.73 The conversion factors are derived from the definitions of the metric system prefixes.

a. $1\text{ kL} = 10^{3}\text{ L}$ The conversion factors are: $\frac{1\text{ kL}}{10^{3}\text{ L}}$ or $\frac{10^{3}\text{ L}}{1\text{ kL}}$

b. $1\text{ mg} = 10^{-3}\text{ g}$ The conversion factors are: $\frac{1\text{ mg}}{10^{-3}\text{ g}}$ or $\frac{10^{-3}\text{ g}}{1\text{ mg}}$

c. $1\text{ cm} = 10^{-2}\text{ m}$ The conversion factors are: $\frac{1\text{ cm}}{10^{-2}\text{ m}}$ or $\frac{10^{-2}\text{ m}}{1\text{ cm}}$

d. $1\mu\text{sec} = 10^{-6}\text{ sec}$ The conversion factors are: $\frac{1\ \mu\text{sec}}{10^{-6}\text{ sec}}$ or $\frac{10^{-6}\text{ sec}}{1\ \mu\text{sec}}$

2.74 a. $\dfrac{1\text{ ng}}{10^{-9}\text{ g}}$ or $\dfrac{10^{-9}\text{ g}}{1\text{ ng}}$ b. $\dfrac{10^{-1}\text{ L}}{1\text{ dL}}$ or $\dfrac{1\text{ dL}}{10^{-1}\text{ L}}$

c. $\dfrac{10^{6}\text{ m}}{1\text{ Mm}}$ or $\dfrac{1\text{ Mm}}{10^{6}\text{ m}}$ d. $\dfrac{10^{-12}\text{ sec}}{1\text{ psec}}$ or $\dfrac{1\text{ psec}}{10^{-12}\text{ sec}}$

2.75 Exact numbers occur in definitions, counting and simple fractions. Inexact numbers result when a measurement is made.

a. 1 dozen = 12 objects This is a definition, so the conversion factors are exact numbers.

b. 1 kilogram = 2.20 pounds This equality is measured, so the conversion factors are inexact numbers.

c. 1 minute = 60 seconds The equality is derived from a definition; the conversion factors are exact numbers.

d. 1 millimeter = 10^{-3} meters The equality is derived from a definition; the conversion factors are exact numbers.

2.76 a. exact b. exact c. inexact d. exact

2.77 Using dimensional analysis: (1) identify the given quantity and its unit, and the unknown quantity and its unit and (2) multiply the given quantity by a conversion factor that allows cancellation of any units not desired in the answer.

a. 1.6×10^3 dm is the given quantity. The unknown quantity will be in meters. The equality is 1 dm = 10^{-1} m, and the conversion factors are:

$$\frac{1\text{ dm}}{10^{-1}\text{ m}} \quad \text{or} \quad \frac{10^{-1}\text{ m}}{1\text{ dm}}$$

The second of these will allow the cancellation of decimeters and leave meters.

$$1.6 \times 10^{3}\text{ dm} \times \left(\frac{10^{-1}\text{ m}}{1\text{ dm}}\right) = 1.6 \times 10^{2}\text{ m}$$

b. Convert 24 nm to meters. The equality is 1 nm = 10^{-9} m.

$$24\text{ nm} \times \left(\frac{10^{-9}\text{ m}}{1\text{ nm}}\right) = 2.4 \times 10^{-8}\text{ m}$$

c. Convert 0.003 km to meters. The equality is 1 km = 10^{3} m.

$$0.003\text{ km} \times \left(\frac{10^{3}\text{ m}}{1\text{ km}}\right) = 3\text{ m}$$

d. Convert 3.0×10^{8} mm to meters. The equality is 1 mm = 10^{-3} m.

$$3.0 \times 10^{8}\text{ mm} \times \left(\frac{10^{-3}\text{ m}}{1\text{ mm}}\right) = 3.0 \times 10^{5}\text{ m}$$

2.78 a. $2.7 \times 10^3 \text{ mm} \times \left(\frac{10^{-3}\text{ m}}{1\text{ mm}}\right) = 2.7\text{ m}$

b. $24\ \mu\text{m} \times \left(\frac{10^{-6}\text{ m}}{1\ \mu\text{m}}\right) = 2.4 \times 10^{-5}\text{ m}$

c. $0.003\text{ pm} \times \left(\frac{10^{-12}\text{ m}}{1\text{ pm}}\right) = 3 \times 10^{-15}\text{ m}$

d. $4.0 \times 10^5\text{ cm} \times \left(\frac{10^{-2}\text{ m}}{1\text{ cm}}\right) = 4.0 \times 10^3\text{ m}$

2.79 Convert 2500 mL to liters. The equality is 1 mL = 10^{-3} L.

$$2500\text{ mL} \times \left(\frac{10^{-3}\text{ L}}{1\text{ mL}}\right) = 2.5\text{ L}$$

2.80 $450\text{ mL} \times \left(\frac{10^{-3}\text{ L}}{1\text{ mL}}\right) = 0.45\text{ L}$

2.81 Convert 1550 g to pounds. Some conversion factors relating the English and Metric Systems of measurement can be found in Table 2.2 of your textbook.

$$1550\text{ g} \times \left(\frac{1.00\text{ lb}}{454\text{ g}}\right) = 3.41\text{ lb}$$

2.82 $0.0030\text{ g} \times \left(\frac{1.00\text{ lb}}{454\text{ g}}\right) = 6.6 \times 10^{-6}\text{ lb}$

2.83 Convert 25 mL to gallons. For this conversion, use two conversion factors, one derived from the defined relationship of mL and L, and the other, relating gallons and liters, from Table 2.2.

$$25\text{ mL} \times \left(\frac{10^{-3}\text{ L}}{1\text{ mL}}\right) \times \left(\frac{0.265\text{ gal}}{1.00\text{ L}}\right) = 0.0066\text{ gal}$$

2.84 $17.0\text{ gal} \times \left(\frac{1.00\text{ L}}{0.265\text{ gal}}\right) \times \left(\frac{1\text{ mL}}{10^{-3}\text{ L}}\right) = 6.42 \times 10^4\text{ mL}$

2.85 Convert 83.2 kg to pounds. See Table 2.2 in your textbook for the conversion factor relating kilograms and pounds.

$$83.2 \text{ kg} \times \left(\frac{2.20 \text{ lb}}{1.00 \text{ kg}}\right) = 183 \text{ lb}$$

Convert 1.92 m to feet. Use two conversion factors: the relationship between inches and meters from Table 2.2, and the defined relationship between feet and inches.

$$1.92 \text{ m} \times \left(\frac{39.4 \text{ in.}}{1.00 \text{ m}}\right) \times \left(\frac{1 \text{ ft}}{12 \text{ in.}}\right) = 6.30 \text{ ft}$$

2.86 $$135 \text{ lb} \times \left(\frac{1.00 \text{ kg}}{2.20 \text{ lb}}\right) = 61.4 \text{ kg}$$

5 ft 4 in. = 64 in.

$$64 \text{ in.} \times \left(\frac{1.00 \text{ m}}{39.4 \text{ in.}}\right) = 1.6 \text{ m}$$

2.87 Exact numbers occur in definitions (1 foot = 12 inches). Therefore the answer will have the same number of significant figures as the measurement.

a. 4.3 feet – two significant figures
b. 3.09 feet – three significant figures
c. 0.33030 feet – five significant figures
d. 5.12310 feet – six significant figures

2.88 a. 2 b. 5 c. 6 d. 3

2.89 The conversion factor is obtained from a measurement (1 inch = 2.540 cm). Therefore, the answer will have the same number of significant figures as the number in the measurement or the conversion factor with the least number of significant figures.

a. 4.3 cm – two significant figures
b. 3.09 cm – three significant figures
c. 0.33030 cm – four significant figures
d. 5.12310 cm – four significant figures

2.90 a. 2 b. 4 c. 4 d. 3

2.91 Density is the ratio of the mass of an object to the volume occupied by that object. To calculate the density of mercury, substitute the given mass and volume values into the defining formula for density.

$$\text{Density} = \text{mass/volume} = \frac{524.5 \text{ g}}{38.72 \text{ cm}^3} = 13.55 \frac{\text{g}}{\text{cm}^3}$$

2.92 $$\frac{12.0 \text{ g}}{2.69 \text{ cm}^3} = 4.46 \frac{\text{g}}{\text{cm}^3}$$

2.93 Use the reciprocal of the density of acetone, 0.791 g/mL, as a conversion factor to convert 20.0 g of acetone to milliliters.

$$20.0 \text{ g} \times \left(\frac{1 \text{ mL}}{0.791 \text{ g}}\right) = 25.3 \text{ mL}$$

2.94 $100.0\text{ g} \times \left(\dfrac{1\text{ cm}^3}{10.40\text{ g}}\right) = 9.615\text{ cm}^3$

2.95 Use the density of homogenized milk, 1.03 g/mL, as a conversion factor to convert 236 mL of homogenized milk to grams.

$$236\text{ mL} \times \left(\frac{1.03\text{ g}}{1\text{ mL}}\right) = 243\text{ g}$$

2.96 $15\text{ cm}^3 \times \left(\dfrac{8.90\text{ g}}{1\text{ cm}^3}\right) = 130\text{ g}$

2.97 An object or a water-insoluble substance will float in water if its density is less than that of water, 1.0 g/cm^3.
a. Paraffin wax will float in water because its density, 0.90 g/cm^3, is less than that of water.
b. Limestone will sink in water because its density, 2.8 g/cm^3, is greater than that of water.

2.98 a. rise b. sink

2.99 Density = mass/volume The answer will have the same number of significant figures as the measurement with the least number of significant figures.
a. Density = $1.0\text{ g} \div 2.0\text{ cm}^3 = 5.0 \times 10^{-1}\text{ g/cm}^3$
b. Density = $1.000\text{ g} \div 2.00\text{ cm}^3 = 5.00 \times 10^{-1}\text{ g/cm}^3$
c. Density = $1.0000\text{ g} \div 2.0000\text{ cm}^3 = 5.0000 \times 10^{-1}\text{ g/cm}^3$
d. Density = $1.000\text{ g} \div 2.0000\text{ cm}^3 = 5.000 \times 10^{-1}\text{ g/cm}^3$

2.100 a. 5.00×10^{-1} b. 5.0×10^{-1} c. 5.000×10^{-1} d. 5.000×10^{-1}

2.101 Calculate the volume of the given mass of substance by using density as a conversion factor.

a. Gasoline: $75.0\text{ g} \times \dfrac{1.0\text{ mL}}{0.56\text{ g}} = 1.3\text{ x }10^2\text{ mL}$

b. Sodium metal: $75.0\text{ g} \times \dfrac{1.0\text{ cm}^3}{0.93\text{ g}} \times \dfrac{1.0\text{ mL}}{1.0\text{ cm}^3} = 81\text{ mL}$

c. Ammonia gas: $75.0\text{ g} \times \dfrac{1.00\text{ L}}{0.759\text{ g}} \times \dfrac{1000\text{ mL}}{1.00\text{ L}} = 9.88\text{ x }10^4\text{ mL}$

d. Mercury: $75.0\text{ g} \times \dfrac{1.00\text{ mL}}{13.6\text{ g}} = 5.51\text{ mL}$

2.102 a. 64.3 mL b. 51,200 mL c. 5.84 mL d. 64.1 mL

2.103 The relationship between the Fahrenheit and Celsius temperature scales can be stated in the form of an equation:

$$^{\circ}F = \frac{9}{5}(^{\circ}C) + 32 \quad \text{or} \quad ^{\circ}C = \frac{5}{9}(^{\circ}F - 32)$$

To find the temperature for baking pizza in degrees Celsius, substitute the degrees Fahrenheit in the appropriate form of the equation and solve for ºC.

$$\frac{5}{9}\left(525^{\circ} - 32^{\circ}\right) = 274^{\circ}C$$

2.104 $\frac{5}{9}\left(95^{\circ} - 32^{\circ}\right) = 35^{\circ}C$

2.105 Convert the freezing point of mercury, –38.9ºC, to degrees Fahrenheit using the appropriate equation.

$$\frac{9}{5}\left(-38.9^{\circ}\right) + 32.0^{\circ} = -38.0^{\circ}F$$

2.106 $\frac{9}{5}\left(29.1^{\circ}\right) + 32.0^{\circ} = 84.4^{\circ}F$

2.107 Convert one of the temperatures to the other temperature scale.

$$\frac{9}{5}\left(-10^{\circ}\right) + 32^{\circ} = 14^{\circ}F; \; -10^{\circ}C \text{ is higher}$$

2.108 $\frac{9}{5}\left(-15^{\circ}\right) + 32.0^{\circ} = 5^{\circ}F; \; -15^{\circ}C$ is higher