

# Answers to Selected Exercises

The answers listed here are from the *Complete Solutions Guide*, in which rounding is carried out at each intermediate step in a calculation in order to show the correct number of significant figures for that step. Therefore, an answer given here may differ in the last digit from the result obtained by carrying extra digits throughout the entire calculation and rounding at the end (the procedure you should follow).

## Chapter 1

**19.** A law summarizes what happens, e.g., law of conservation of mass in a chemical reaction or the ideal gas law,  $PV = nRT$ . A theory (model) is an attempt to explain why something happens. Dalton's atomic theory explains why mass is conserved in a chemical reaction. The kinetic molecular theory explains why pressure and volume are inversely related at constant temperature and moles of gas. **21.** The fundamental steps are (1) making observations; (2) formulating hypotheses; (3) performing experiments to test the hypotheses. The key to the scientific method is performing experiments to test hypotheses. If after the test of time, the hypotheses seem to account satisfactorily for some aspect of natural behavior, then the set of tested hypotheses turns into a theory (model). However, scientists continue to perform experiments to refine or replace existing theories. **23.** A qualitative observation expresses what makes something what it is; it does not involve a number; e.g., the air we breathe is a mixture of gases, ice is less dense than water, rotten milk stinks. The SI units are mass in grams, length in meters, and volume in the derived units of  $m^3$ . The assumed uncertainty in a number is  $\pm 1$  in the last significant figure of the number. The precision of an instrument is related to the number of significant figures associated with an experimental reading on that instrument. Different instruments for measuring mass, length, or volume have varying degrees of precision. Some instruments only give a few significant figures for a measurement while others will give more significant figures. **25.** Significant figures are the digits we associate with a number. They contain all of the certain digits and the first uncertain digit (the first estimated digit). What follows is one thousand indicated to varying numbers of significant figures: 1000 or  $1 \times 10^3$  (1 S.F.);  $1.0 \times 10^3$  (2 S.F.);  $1.00 \times 10^3$  (3 S.F.); 1000. or  $1.000 \times 10^3$  (4 S.F.). To perform the calculation, the addition/subtraction significant rule is applied to  $1.3 - 1.0$ . The result of this is the one significant figure answer of 0.3. Next, the multiplication/division rule is applied to 0.50/50. A one significant number divided by a two-significant number yields an answer with one significant figure (answer = 1). **27.** The slope of the  $V_T$  vs.  $T_C$  plot is 1.8 (= 9/5) and the y-intercept is 32°F. The slope of  $V_C$  vs.  $T_K$  plot is 1 and the y-intercept is  $-273^\circ\text{C}$ . **29.** The density of a gas is much smaller than the density of a solid or a liquid. The molecules in a solid and a liquid are very close together, whereas in the gas phase, the molecules are very far apart. **31.** a. exact; b. inexact; c. exact; d. inexact. **33.** a. 3; b. 4; c. 4; d. 1; e. 7; f. 1; g. 3; h. 3. **35.** a.  $3.42 \times 10^{-7}$ ; b.  $1.034 \times 10^4$ ; c.  $1.7992 \times 10^4$ ; d.  $3.37 \times 10^2$ ; e.  $2.83 + 0.280 = 3.11$  mL; the graduated cylinder on the left limits the precision of the total volume; it is the least precise measuring device between the two graduated cylinders. **39.** a. 641.0; b. 1.327; c. 77.34; d. 3213; e. 0.420. **41.** a. 188.1; b. 12; c.  $4 \times 10^{-7}$ ; d.  $6.3 \times 10^{-26}$ ; e. 4.9; Uncertainty appears in the first decimal place. The average of several numbers can be only as precise as the least precise number. Averages can be exceptions to the significant figure rules. **43.** a. 84.3 mm; b. 2.41 m; c.  $2.945 \times 10^{-3}$  cm; d. 14.45 km; e.  $2.353 \times 10^5$  mm; f.  $0.9833 \mu\text{m}$ . **45.** a. 6 lb and 9.9 oz; 202 in; b.  $4.0 \times 10^4$  km,  $4.0 \times 10^7$  m; c.  $1.2 \times 10^{-3}$  m<sup>3</sup>, 1.2 L, 750 mL, 0.42 m<sup>3</sup>; d.  $4.00 \times 10^3$  rods; 10.0 furlongs;  $2.01 \times 10^3$  m; 2.01 km;  $8.5900 \times 10^3$  rods; 209.75 furlongs; 42,195 m; 42,195 km. **49.** a. 0.373 kg, 0.822 lb; b. 31.1 g, 156 carats; c. 19.3 cm<sup>3</sup>. **51.** 24 capsules. **53.**  $2.91 \times 10^3$  knots; 3.36  $\times$

$10^3$  m/s. **55.** 100 ft. **57.** 18 g. **59.**  $7 \times 10^2$  kg mercury. **61.** a.  $-273^\circ\text{C}$ , 0 K; b.  $-40^\circ\text{C}$ , 233 K; c.  $20^\circ\text{C}$ , 293 K; d.  $4 \times 10^2$  °C,  $4 \times 10^2$  K. **63.** a. 312.4 K; 102.6°F; b. 248 K;  $-17^\circ\text{F}$ ; c. 0 K;  $-459^\circ\text{F}$ ; d. 1074 K; 1470°F. **65.** 160.°C = 320°F. **67.** a.  $T_C = (T_F + 10^\circ\text{C}) \frac{5}{9}$ ; b. 11.4°C; c. 152°C; 425 K; 306°F. **69.** It will float (density = 0.80 g/cm<sup>3</sup>). **71.**  $1 \times 10^3$  g/cm<sup>3</sup>. **73.** a. 0.28 cm<sup>3</sup>; b. 49 carats. **75.** 3.8 g/cm<sup>3</sup>. **77.** a. Both are the same mass; b. 1.0 mL mercury; c. Both are the same mass; d. 1.0 L benzene. **79.** a. 1.0 kg feather; b. 100 g water; c. same. **81.** 2.77 cm. **83.** a. Picture iv represents a gaseous compound. Pictures ii and iii also contain a gaseous compound but have a gaseous element present. b. Picture vi represents a mixture of two gaseous elements. c. Picture v represents a solid element. d. Pictures ii and iii both represent a mixture of a gaseous element and a gaseous compound. **85.** a. heterogeneous; b. homogeneous (hopefully); c. homogeneous; d. homogeneous (hopefully); e. heterogeneous; f. heterogeneous. **87.** a. pure; b. mixture; c. mixture; d. pure; e. mixture (copper and zinc); f. pure; g. mixture; h. mixture; i. mixture. Iron and uranium are elements. Water is a compound. Table salt is usually a homogeneous mixture composed mostly of sodium chloride (NaCl), but it usually will contain other substances that help absorb water vapor (an anticaking agent). **89.** Compound. **91.** a. physical; b. chemical; c. physical; d. chemical. **93.** The sphere that floats has the smaller density; this will be the object that has the same mass in a larger volume. So the object with the larger diameter will have the larger volume and will have the smaller density; the larger sphere will float. **95.** 0.010 kg. **97.**  $1.0 \times 10^2$  bags. **99.**  $3.0 \times 10^{17}$  m. **101.** a. 1.1 g; b. 4.9 g. **103.** 14 g. **105.** 56.56°C. **107.** a. Volume  $\times$  density = mass; the orange block is more dense. Since mass (orange)  $>$  mass (blue) and volume (orange)  $<$  volume (blue), the density of the orange block must be greater to account for the larger mass of the orange block. b. Which block is more dense cannot be determined. Since mass (orange)  $>$  mass (blue) and volume (orange)  $>$  volume (blue), the density of the orange block may or may not be larger than the blue block. If the blue block is more dense, then its density cannot be so large that the mass of the smaller blue block becomes larger than the orange block mass. c. The blue block is more dense. Since mass (blue) = mass (orange) and volume (blue)  $<$  volume (orange), the density of the blue block must be larger to equate the masses. d. The blue block is more dense. Since mass (blue)  $>$  mass (orange) and the volumes are equal, the density of the blue block must be larger to give the blue block the larger mass. **109.**  $8.5 \pm 0.5$  g/cm<sup>3</sup>. **111.**  $3.648 \times 10^3$  nautical lengths;  $6.671 \times 10^2$  m; 3648 nautical miles. **113.** Phosphorus would be a liquid. **115.** a. False; sugar is generally considered to be the pure compound sucrose, C<sub>12</sub>H<sub>22</sub>O<sub>11</sub>. b. False; elements and compounds are pure substances. c. True; air is a mixture of mostly nitrogen and oxygen gases. d. False; gasoline has many additives, so it is a mixture. e. True; compounds are broken down to elements by chemical change. **117.** In a subtraction, the result gets smaller, but the uncertainties add. If the two numbers are very close together, the uncertainty may be larger than the result. For example, let us assume we want to take the difference of the following two measured quantities, 999,999  $\pm 2$  and 999,996  $\pm 2$ . The difference is 3  $\pm 4$ . Because of the larger uncertainty, subtracting two similar numbers is bad practice. **119.** a. 2%; b. 2.2%; c. 0.2%. **121.**  $d_{\text{max}} = 0.8$  g/cm<sup>3</sup>,  $d_{\text{min}} = 7.17$  g/cm<sup>3</sup>,  $d_{\text{max}}/d_{\text{min}} = \text{mass}_{\text{max}}/\text{mass}_{\text{min}} = 0.81$ . The difference in mass is accounted for by the difference in the alloy used (if the assumptions are correct). **123.** 7.0% **125.** a. One possibility is that rope B is not attached to anything and rope A and rope C are connected via a pair of pulleys and/or gears. b. Try to pull rope B out of the box. Measure the distance moved by C for a given movement of A. Hold either A or C firmly while pulling on the other rope. **127.** 5160/person;  $3.20 \times 10^3$  nickels/person.

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**Raffaela Di Napoli**



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