CHAPTER 2

STANDARDS FOR MEASUREMENT

SOLUTIONS TO REVIEW QUESTIONS

1. The exponent will be positive for a large number and negative for a small number.

2. The exponent will decrease.

3. The last digit in a measurement is uncertain because if the quantity were to be measured multiple times, the last digit would vary.

4. It must be written in scientific notation as 6.420×10^5 g.

5. Zeroes are significant when they are between non-zero digits or at the end of a number that includes a decimal point.

6. Rule 1. When the first digit after those you want to retain is 4 or less, that digit and all others to its right are dropped. The last digit retained is not changed.

   Rule 2. When the first digit after those you want to retain is 5 or greater, that digit and all others to the right of it are dropped and the last digit retained is increased by one.

7. No, the number of significant digits in the calculated value may not be more than the number of significant figures in any of the measurements.

8. Yes, the number of significant digits depends on the precision of each of the individual measurements and the calculated value may have more or fewer significant figures than the original measurements as long as the precision is no greater than the measurement with the lowest precision. An example of a calculation with an increase in significant figures is in example 2.9.

9. $100\text{ cm} = 1\text{ m}$

   $1{,}000{,}000{,}000\text{ nm} = 1\text{ m}$ $\qquad (1\text{ cm})\left(\frac{1\text{ m}}{100\text{ cm}}\right)\left(\frac{1{,}000{,}000{,}000\text{ nm}}{\text{m}}\right) = 10{,}000{,}000\text{ nm}$

10. $1000\text{ mg} = 1\text{ g}$

    $1000\text{ g} = 1\text{ kg}$ $\qquad (1\text{ kg})\left(\frac{1000\text{ g}}{\text{kg}}\right)\left(\frac{1000\text{ mg}}{\text{g}}\right) = 1{,}000{,}000\text{ mg}$

11. Weight is a measure of how much attraction the earth's gravity has for an object (or person). In this case, the farther the astronaut is from the earth the less gravitational force is pulling on him or her. Less gravitational attraction means the astronaut will weigh less. The mass of the astronaut is the amount of matter that makes up him or her. This does not change as the astronaut moves away from the earth.

12. They are equivalent units.

13. $(3.5\text{ in.})\left(\frac{2.54\text{ cm}}{1\text{ in.}}\right) = 8.9\text{ cm}$

14. Heat is a form of energy, while temperature is a measure of the intensity of heat (how hot the system is).

15. The number of degrees between the freezing and boiling point of water are

Fahrenheit	180°F
Celsius	100°C
Kelvin	100 K

16. The three materials would sort out according to their densities with the most dense (mercury) at the bottom and the least dense (glycerin) at the top. In the cylinder, the solid magnesium would sink in the glycerin and float on the liquid mercury.

17. Order of increasing density: ethyl alcohol, vegetable oil, salt, lead.

18. The density of ice must be less than 0.91 g/mL and greater than 0.789 g/mL.

19. Density is the ratio of the mass of a substance to the volume occupied by that mass. Density has the units of mass over volume. Specific gravity is the ratio (no units) of the density of a substance to the density of a reference substance (usually water at a specific temperature for solids and liquids). Specific gravity has no units.

20. The density of water is 1.0 g/mL at approximately 4°C. However, when water changes from a liquid to a solid at 0°C there is actually an increase in volume. The density of ice at 0°C is 0.917 g/mL. Therefore, ice floats in water because solid water is less dense than liquid water.

21. If you collect a container of oxygen gas, you should store it with the mouth up. Oxygen gas is denser than air.

22. density of gold = 19.3 g/mL density of silver = 10.5 g/mL

$(25\text{ g gold})\left(\frac{1\text{ mL}}{19.3\text{ g}}\right) = 1.3\text{ mL}$

$(25\text{ g silver})\left(\frac{1\text{ mL}}{10.5\text{ g}}\right) = 2.4\text{ mL}$ 25 g of silver has the greater volume.

SOLUTIONS TO EXERCISES

1. (a) kilogram = 1000 grams
   (b) centimeter = 1/100 of a meter (0.01 m)
   (c) microliter = 1/1,000,000 of a liter (0.000001 L)
   (d) millimeter = 1/1000 of a meter (0.001 m)
   (e) deciliter = 1/10 of a liter (0.1 L)

2. (a) 1000 meters = 1 kilometer
   (b) 0.1 gram = 1 decigram
   (c) 0.000001 liter = 1 microliter
   (d) 0.01 meter = 1 centimeter
   (e) 0.001 liter = 1 milliliter

3. (a) gram = g
   (b) microgram = μg
   (c) centimeter = cm
   (d) micrometer = μm
   (e) milliliter = mL
   (f) deciliter = dL

4. (a) milligram = mg
   (b) kilogram = kg
   (c) meter = m
   (d) nanometer = nm
   (e) angstrom = Å
   (f) microliter = μL

5. (a) 2050 — the first zero is significant; the last zero is not significant
   (b) 9.00×10^2 — zeros are significant
   (c) 0.0530 — the first two zeros are not significant; the last zero is significant
   (d) 0.075 — zeros are not significant
   (e) 300. — zeros are significant
   (f) 285.00 — zeros are significant

6. (a) 0.005 — zeros are not significant
   (b) 1500 — zeros are not significant
   (c) 250. — zero is significant
   (d) 10.000 — zeros are significant
   (e) 6.070×10^4 — zeros are significant
   (f) 0.2300 — the first zero is not significant; the last two zeros are significant

7. Significant figures
   (a) 0.025 (2 sig. fig.)
   (b) 22.4 (3 sig. fig.)
   (c) 0.0404 (3 sig. fig.)
   (d) 5.50×10^3 (3 sig. fig.)

8. Significant figures
   (a) 40.0 (3 sig. fig.)
   (b) 0.081 (2 sig. fig.)
   (c) 129,042 (6 sig. fig.)
   (d) 4.090×10^{-3} (4 sig. fig.)

9. Round to three significant figures
   (a) 93.2
   (b) 0.0286
   (c) 4.64
   (d) 34.3

10. Round to three significant figures
   (a) 8.87
   (b) 21.3
   (c) 130. (1.30×10^2)
   (d) 2.00×10^6

11. Exponential notation
   (a) 2.9×10^6
   (b) 5.87×10^{-1}
   (c) 8.40×10^{-3}
   (d) 5.5×10^{-6}

12. Exponential notation
   (a) 4.56×10^{-2}
   (b) 4.0822×10^3
   (c) 4.030×10^1
   (d) 1.2×10^7

13. (a)
$$\begin{array}{r} 12.62 \\ 1.5 \\ 0.25 \\ \hline 14.37 \end{array} = 14.4$$
   (b) $(2.25 \times 10^3)(4.80 \times 10^4) = 10.8 \times 10^7 = 1.08 \times 10^8$
   (c) $\dfrac{(452)(6.2)}{14.3} = 195.97 = 2.0 \times 10^2$
   (d) $(0.0394)\ (12.8) = 0.504$
   (e) $\dfrac{0.4278}{59.6} = 0.00718 = 7.18 \times 10^{-3}$
   (f) $10.4 + (3.75)(1.5 \times 10^4) = 5.6 \times 10^4$

14. (a)
$$\begin{array}{r} 15.2 \\ -2.75 \\ 15.67 \\ \hline 28.1 \end{array}$$
   (b) $(4.68)\ (12.5) = 58.5$
   (c) $\dfrac{182.6}{4.6} = 40.$
   (d)
$$\begin{array}{r} 1986 \\ 23.84 \\ 0.012 \\ \hline 2009.852 \end{array} = 2010. = 2.010 \times 10^3$$
   (e) $\dfrac{29.3}{(284)(415)} = 2.49 \times 10^{-4}$
   (f) $(2.92 \times 10^{-3})(6.14 \times 10^5) = 1.79 \times 10^3$

15. Fractions to decimals (3 significant figures)
   (a) $\dfrac{5}{6} = 0.833$
   (b) $\dfrac{3}{7} = 0.429$
   (c) $\dfrac{12}{16} = 0.750$
   (d) $\dfrac{9}{18} = 0.500$

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16. Decimals to fractions

(a) $0.25 = \frac{1}{4}$

(b) $0.625 = \frac{5}{8}$

(c) $1.67 = 1\frac{2}{3}$ or $\frac{5}{3}$

(d) $0.888 = \frac{8}{9}$

17. (a) $3.42x = 6.5$

$x = \frac{6.5}{3.42} = 1.9$

(b) $\frac{x}{12.3} = 7.05$

$x = (7.05)(12.3) = 86.7$

(c) $\frac{0.525}{x} = 0.25$

$0.525 = 0.25x$

$x = \frac{0.525}{0.25} = 2.1$

18. (a) $x = \frac{212 - 32}{1.8}$

$x = 1.0 \times 10^2$

(b) $8.9 \frac{\text{g}}{\text{mL}} = \frac{40.90 \text{ g}}{x}$

$\left(8.9 \frac{\text{g}}{\text{mL}}\right) x = 40.90 \text{ g}$

$x = \frac{40.90 \text{ g}}{8.9 \frac{\text{g}}{\text{mL}}} = 4.6 \text{ mL}$

(c) $72 = 1.8x + 32$

$72 - 32 = 1.8x$

$40. = 1.8x$

$\frac{40.}{1.8} = x$

$22 = x$

19. (a) $(28.0 \text{ cm})\left(\frac{1 \text{ m}}{100 \text{ cm}}\right) = 0.280 \text{ m}$

(b) $(1000. \text{ m})\left(\frac{1 \text{ km}}{1000 \text{ m}}\right) = 1.000 \text{ km}$

(c) $(9.28 \text{ cm})\left(\frac{10 \text{ mm}}{1 \text{ cm}}\right) = 92.8 \text{ mm}$

(d) $(10.68 \text{ g})\left(\frac{1000 \text{ mg}}{1 \text{ g}}\right) = 1.068 \times 10^4 \text{ mg}$

(e) $(6.8 \times 10^4 \text{ mg})\left(\frac{1 \text{ g}}{1000 \text{ mg}}\right)\left(\frac{1 \text{ kg}}{1000 \text{ g}}\right) = 6.8 \times 10^{-2} \text{ kg}$

(f) $(8.54 \text{ g})\left(\frac{1 \text{ kg}}{1000 \text{ g}}\right) = 0.00854 \text{ kg}$

(g) $(25.0 \text{ mL})\left(\frac{1 \text{ L}}{1000 \text{ mL}}\right) = 2.50 \times 10^{-2} \text{ L}$

(h) $(22.4 \text{ L})\left(\frac{10^6 \text{ µL}}{1 \text{ L}}\right) = 2.24 \times 10^7 \text{ µL}$

20. (a) $(4.5\text{ cm})\left(\frac{1\text{ m}}{100\text{ cm}}\right)\left(\frac{1\text{ Å}}{10^{-10}\text{ m}}\right) = 4.5 \times 10^{8}\text{ Å}$

(b) $(12\text{ nm})\left(\frac{10^{-9}\text{ m}}{1\text{ nm}}\right)\left(\frac{100\text{ cm}}{1\text{ m}}\right) = 1.2 \times 10^{-6}\text{ cm}$

(c) $(8.0\text{ km})\left(\frac{1000\text{ m}}{1\text{ km}}\right)\left(\frac{1000\text{ mm}}{1\text{ m}}\right) = 8.0 \times 10^{6}\text{ mm}$

(d) $(164\text{ mg})\left(\frac{1\text{ g}}{1000\text{ mg}}\right) = 0.164\text{ g}$

(e) $(0.65\text{ kg})\left(\frac{1000\text{ g}}{1\text{ kg}}\right)\left(\frac{1000\text{ mg}}{1\text{ g}}\right) = 6.5 \times 10^{5}\text{ mg}$

(f) $(5.5\text{ kg})\left(\frac{1000\text{ g}}{1\text{ kg}}\right) = 5.5 \times 10^{3}\text{ g}$

(g) $(0.468\text{ L})\left(\frac{1000\text{ mL}}{1\text{ L}}\right) = 468\text{ mL}$

(h) $(9.0\ \mu\text{L})\left(\frac{1\text{ L}}{10^{6}\ \mu\text{L}}\right)\left(\frac{1000\text{ mL}}{1\text{ L}}\right) = 9.0 \times 10^{-3}\text{ mL}$

21. (a) $(42.2\text{ in.})\left(\frac{2.54\text{ cm}}{1\text{ in.}}\right) = 107\text{ cm}$

(b) $(0.64\text{ mi})\left(\frac{5280\text{ ft}}{1\text{ mi}}\right)\left(\frac{12\text{ in.}}{1\text{ ft}}\right) = 4.1 \times 10^{4}\text{ in.}$

(c) $(2.00\text{ in.}^2)\left(\frac{2.54\text{ cm}}{1\text{ in.}}\right)^2 = 12.9\text{ cm}^2$

(d) $(42.8\text{ kg})\left(\frac{2.205\text{ lb}}{\text{kg}}\right) = 94.4\text{ lb}$

(e) $(3.5\text{ qt})\left(\frac{946\text{ mL}}{1\text{ qt}}\right) = 3.3 \times 10^{3}\text{ mL}$

(f) $(20.0\text{ L})\left(\frac{1\text{ qt}}{0.946\text{ L}}\right)\left(\frac{1\text{ gal}}{4\text{ qt}}\right) = 5.29\text{ gal}$

22. (a) The conversion is: m → cm → in. → ft

$(35.6\text{ m})\left(\frac{100\text{ cm}}{1\text{ m}}\right)\left(\frac{1\text{ in.}}{2.54\text{ cm}}\right)\left(\frac{1\text{ ft}}{12\text{ in.}}\right) = 117\text{ ft}$

(b) $(16.5\text{ km})\left(\frac{1\text{ mi}}{1.609\text{ km}}\right) = 10.3\text{ mi}$

(c) $(4.5\text{ in.}^3)\left(\frac{2.54\text{ cm}}{1\text{ in.}}\right)^3\left(\frac{10\text{ mm}}{1\text{ cm}}\right)^3 = 7.4 \times 10^{4}\text{ mm}^3$

(d) $(95\text{ lb})\left(\frac{453.6\text{ g}}{1\text{ lb}}\right) = 4.3 \times 10^{4}\text{ g}$

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(e) $(20.0\text{ gal})\left(\frac{4\text{ qt}}{1\text{ gal}}\right)\left(\frac{0.946\text{ L}}{1\text{ qt}}\right) = 75.7\text{ L}$

(f) The conversion is: $\text{ft}^3 \rightarrow \text{in.}^3 \rightarrow \text{cm}^3 \rightarrow \text{m}^3$

$$(4.5 \times 10^4\text{ ft}^3)\left(\frac{12\text{ in.}}{1\text{ ft}}\right)^3\left(\frac{2.54\text{ cm}}{1\text{ in.}}\right)^3\left(\frac{1\text{ m}}{100\text{ cm}}\right)^3 = 1.3 \times 10^3\text{ m}^3$$

23. The conversion is: $\frac{\text{mi}}{\text{min}} \rightarrow \frac{\text{km}}{\text{min}} \rightarrow \frac{\text{km}}{\text{hr}}$

$$\left(\frac{15.2\text{ mi}}{45\text{ min}}\right)\left(\frac{1.609\text{ km}}{1\text{ mi}}\right)\left(\frac{60\text{ min}}{1\text{ hr}}\right) = 33\,\frac{\text{km}}{\text{hr}}$$

24. The conversion is: $\frac{\text{km}}{\text{s}} \rightarrow \frac{\text{mi}}{\text{s}} \rightarrow \frac{\text{mi}}{\text{hr}}$

$$\left(\frac{5.0\text{ km}}{923\text{ s}}\right)\left(\frac{1\text{ mi}}{1.609\text{ km}}\right)\left(\frac{3600\text{ s}}{1\text{ hr}}\right) = 12\,\frac{\text{mi}}{\text{hr}}$$

25. The conversion is: L → mL → mg → g

$$(1\text{ L})\left(\frac{1000\text{ mL}}{1\text{ L}}\right)\left(\frac{500.\text{ mg}}{100.\text{ mL}}\right)\left(\frac{1\text{ g}}{1000\text{ mg}}\right) = 5.00\text{ g}$$

26. The conversion is: tablet → g → mg → grains

$$(1\text{ tablet})\left(\frac{0.500\text{ g}}{1\text{ tablet}}\right)\left(\frac{1000\text{ mg}}{1\text{ g}}\right)\left(\frac{1\text{ grain}}{60\text{ mg}}\right) = 8.33\text{ grains}$$

27. The conversion is: hr → min → s → m → km → mi

$$(5\text{ hours})\left(\frac{60\text{ min}}{1\text{ hr}}\right)\left(\frac{60\text{ s}}{1\text{ min}}\right)\left(\frac{0.11\text{ m}}{1\text{ s}}\right)\left(\frac{1\text{ km}}{1000\text{ m}}\right)\left(\frac{1\text{ mi}}{1.61\text{ km}}\right) = 1.2\text{ miles}$$

28. The conversion is: cm → in. → ft → yr → day

$$(1\text{ cm})\left(\frac{1\text{ in.}}{2.54\text{ cm}}\right)\left(\frac{1\text{ ft}}{12\text{ in.}}\right)\left(\frac{1\text{ yr}}{3.38\text{ ft}}\right)\left(\frac{365\text{ day}}{1\text{ yr}}\right) = 3.54\text{ days}$$

29. The conversion is: lb body → lb fat → kg fat

$$(225\text{ lb body})\left(\frac{11.2\text{ lb fat}}{100\text{ lb body}}\right)\left(\frac{1\text{ kg}}{2.205\text{ lb}}\right) = 11.4\text{ kg fat}$$

30. The conversion is: carats → mg → g → lb

$$(5.75\text{ carats})\left(\frac{200\text{ mg}}{1\text{ carat}}\right)\left(\frac{1\text{ g}}{1000\text{ mg}}\right)\left(\frac{1\text{ lb}}{453.6\text{ g}}\right) = 2.54 \times 10^{-3}\text{ lb}$$

31. The conversion is: $\frac{\text{yd}}{\text{s}} \rightarrow \frac{\text{mi}}{\text{s}} \rightarrow \frac{\text{km}}{\text{s}} \rightarrow \frac{\text{m}}{\text{s}} \rightarrow \frac{\text{m}}{\text{min}}$

$$\left(\frac{100.\text{ yd}}{52\text{ s}}\right)\left(\frac{1\text{ mi}}{1760\text{ yd}}\right)\left(\frac{1.609\text{ km}}{1\text{ mi}}\right)\left(\frac{1000\text{ m}}{1\text{ km}}\right)\left(\frac{60\text{ s}}{1\text{ min}}\right) = 1.1 \times 10^2\,\frac{\text{m}}{\text{min}}$$

32. The conversion is: $\frac{\text{mi}}{\text{hr}} \to \frac{\text{km}}{\text{hr}} \to \frac{\text{m}}{\text{hr}} \to \frac{\text{cm}}{\text{hr}} \to \frac{\text{cm}}{\text{s}}$

$$\left(\frac{133\ \text{mi}}{1\ \text{hr}}\right)\left(\frac{1.609\ \text{km}}{1\ \text{mi}}\right)\left(\frac{1000\ \text{m}}{1\ \text{km}}\right)\left(\frac{100\ \text{cm}}{1\ \text{m}}\right)\left(\frac{1\ \text{hr}}{3600\ \text{s}}\right) = 5.94 \times 10^3\ \frac{\text{cm}}{\text{s}}$$

33. (a) $29{,}035\ \text{ft} - 21{,}002\ \text{ft} = 8033\ (\text{total feet climbed})$

$$(16\ \text{hr})\left(\frac{60\ \text{min}}{\text{hr}}\right) = 960\ \text{min} \quad 960\ \text{min} + 42\ \text{min} = 1.0 \times 10^3\ \text{min}$$

$$\left(\frac{8003\ \text{ft}}{1.0 \times 10^3\ \text{min}}\right)\left(\frac{1\ \text{mi}}{5280\ \text{ft}}\right) = 1.5 \times 10^{-3}\ \frac{\text{mi}}{\text{min}}$$

(b) $$\left(\frac{8003\ \text{ft}}{1.0 \times 10^3\ \text{min}}\right)\left(\frac{1\ \text{mi}}{5280\ \text{ft}}\right)\left(\frac{1.609\ \text{km}}{\text{mi}}\right)\left(\frac{1000\ \text{m}}{\text{km}}\right)\left(\frac{1\ \text{min}}{60\ \text{s}}\right) = 4.1 \times 10^{-2}\ \frac{\text{m}}{\text{s}}$$

34. (a) The conversion is: $\frac{\text{m}}{\text{hr}} \to \frac{\text{cm}}{\text{hr}} \to \frac{\text{in.}}{\text{hr}} \to \frac{\text{ft}}{\text{hr}} \to \frac{\text{hr}}{\text{min}}$

$$\left(\frac{4500\ \text{m}}{5\ \text{hr}}\right)\left(\frac{100\ \text{cm}}{\text{m}}\right)\left(\frac{1\ \text{in.}}{2.54\ \text{cm}}\right)\left(\frac{1\ \text{ft}}{12\ \text{in.}}\right)\left(\frac{1\ \text{hr}}{60\ \text{min}}\right) = 50\ \frac{\text{ft}}{\text{min}}$$

(b) The conversion is: $\frac{\text{m}}{\text{hr}} \to \frac{\text{km}}{\text{m}} \to \frac{\text{hr}}{\text{min}} \to \frac{\text{min}}{\text{s}}$

$$\left(\frac{4500\ \text{m}}{5\ \text{hr}}\right)\left(\frac{1\ \text{km}}{1000\ \text{m}}\right)\left(\frac{1\ \text{hr}}{60\ \text{min}}\right)\left(\frac{1\ \text{min}}{60\ \text{s}}\right) = 3 \times 10^{-4}\ \frac{\text{km}}{\text{s}}$$

35. The conversion is: gal → qt → L → mL → cup

$$(2010\ \text{gal})\left(\frac{4\ \text{qt}}{1\ \text{gal}}\right)\left(\frac{1\ \text{L}}{1.06\ \text{qt}}\right)\left(\frac{1000\ \text{mL}}{1\ \text{L}}\right)\left(\frac{1\ \text{cup}}{473\ \text{mL}}\right) = 1.60 \times 10^4\ \text{cups coffee}$$

36. The conversion is: lb → g → number of tilapia

$$(4.75 \times 10^6\ \text{lb})\left(\frac{454\ \text{g}}{1\ \text{lb}}\right)\left(\frac{1\ \text{tilapia}}{535\ \text{g}}\right) = 4.03 \times 10^6\ \text{tilapia}$$

37. The conversion is: gal → qt → mL → drops

$$(1.0\ \text{gal})\left(\frac{4\ \text{qt}}{\text{gal}}\right)\left(\frac{946\ \text{mL}}{\text{qt}}\right)\left(\frac{20.\ \text{drops}}{\text{mL}}\right) = 7.6 \times 10^4\ \text{drops}$$

38. The conversion is: gal → qt → L

$$(42\ \text{gal})\left(\frac{4\ \text{qt}}{\text{gal}}\right)\left(\frac{0.946\ \text{L}}{\text{qt}}\right) = 160\ \text{L}$$

39. The conversion is: $\text{ft}^3 \to \text{in.}^3 \to \text{cm}^3 \to \text{mL}$

$$(1.00\ \text{ft}^3)\left(\frac{12\ \text{in.}}{1\ \text{ft}}\right)^3\left(\frac{2.54\ \text{cm}}{1\ \text{in.}}\right)^3\left(\frac{1\ \text{mL}}{1\ \text{cm}^3}\right) = 2.83 \times 10^4\ \text{mL}$$

40. $V = A \times h \qquad A = \text{area} \qquad h = \text{height} \qquad V = \text{volume}$

The conversion is: $\frac{cm^3}{nm} \rightarrow \frac{cm^3}{m} \rightarrow m^2$

$$A = \frac{V}{h} = \left(\frac{200\ cm^3}{0.5\ nm}\right)\left(\frac{1\ nm}{10^{-9}\ m}\right)\left(\frac{1\ m}{100\ cm}\right)^3 = 4 \times 10^5\ m^2$$

41. (a) $(27\ cm)\ (21\ cm)\ (4.4\ cm) = 2.5 \times 10^3\ cm^3$

(b) $2.5 \times 10^3\ cm^3$ is $2.5 \times 10^3\ mL\left(\frac{1\ L}{1000\ mL}\right) = 2.5\ L$

(c) $\left(2.5 \times 10^3\ cm^3\right)\left(\frac{1\ in.}{2.54\ cm}\right)^3 = 1.5 \times 10^2\ in.^3$

42. $(16\ in.)(8\ in.)(10\ in.)\left(\frac{2.54\ cm}{1\ in.}\right)^3\left(\frac{1\ L}{1000\ mL}\right)\left(\frac{1\ qt}{0.946\ L}\right)\left(\frac{1\ gal}{4\ qt}\right) = 6\ gal$

43. (a) $°F = 1.8°C + 32 = (1.8)\ (38.8) + 32 = 101.8°F$

(b) Yes, the child has a fever since $101.8°F > 98.6°F$

44. $°F = 1.8°C + 32 \qquad (1.8)\ (45) + 32 = 113°F$ Summer!

45. (a) $\frac{162 - 32}{1.8} = 72.2°C$ Remember to express the answer to the same precision as the original measurement.

(b) $°C + 273 = K \qquad \frac{0.0 - 32}{1.8} + 273 = 255.2\ K$

(c) $1.8(-18) + 32 = -0.40°F$

(d) $212 - 273 = -61°C$

46. (a) $1.8(32) + 32 = 90.°F$

(b) $\frac{-8.6 - 32}{1.8} = -23°C$

(c) $273 + 273 = 546\ K$

(d) $°C = 100 - 273 = -173°C$

$(-173)(1.8) + 32 = -279°F = -300°F$ (1 significant figure in 100 K)

47. $°F = °C$

$°F = 1.8(°C) + 32$ substitute °F for °C

$°F = 1.8(°F) + 32$

$-32 = 0.8(°F)$

$\frac{-32}{0.8} = °F$

$-40 = °F$

$-40°F = -40°C$

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48. $$°F = -°C$$

$$°F = 1.8(°C) + 32 \qquad \text{substitute } -°C \text{ for } °F$$

$$-°C = 1.8(°C) + 32$$

$$2.8(°C) = -32$$

$$°C = \frac{-32}{2.8}$$

$$°C = -11.4$$

$$-11.4°C = 11.4°F$$

49. $°F = 1.8°C + 32 \qquad (1.8)(460) + 32 = 860°F$

50. $°C = \dfrac{°F - 32}{1.8} \qquad \dfrac{(-244) - 32}{1.8} = -153°C$

51. $d = \dfrac{m}{v} = \dfrac{59.82\text{ g}}{65.0\text{ mL}} = 0.920\dfrac{\text{g}}{\text{mL}}$

52. $d = \dfrac{m}{v} = \dfrac{20.41\text{ g}}{25.2\text{ mL}} = 0.810\dfrac{\text{g}}{\text{mL}}$

53. $50.92\text{ g} - 25.23\text{ g} = 25.69\text{ g}$ (mass of liquid)
$d = \dfrac{m}{v} = \dfrac{25.69\text{ g}}{25.0\text{ mL}} = 1.03\dfrac{\text{g}}{\text{mL}}$

54. $54.6\text{ mL} - 50.0\text{ mL} = 4.6\text{ mL}$ (volume of zinc)
$d = \dfrac{m}{v} = \dfrac{32.95\text{ g}}{4.6\text{ mL}} = 7.2\dfrac{\text{g}}{\text{mL}}$

55. The conversion is g → mL
$(15\text{ g})\left(\dfrac{1\text{ mL}}{0.929\text{ g}}\right) = 16\text{ mL}$

56. The conversion is g → mL
$(75\text{ g})\left(\dfrac{1\text{ mL}}{1.20\text{ g}}\right) = 63\text{ mL}$

57. (a) report 10.01 grams
(b) report 10.012 grams
(c) report 10.0124 grams

58. (a) $(175\text{ Skittles})\left(\dfrac{1.134\text{ g Skittle}}{1\text{ Skittle}}\right) = 198\text{ g Skittles}$

(b) $(175\text{ Skittles})\left(\dfrac{5.3\text{ mL Skittles}}{6\text{ Skittles}}\right)\left(\dfrac{1\text{ L Skittles}}{1000\text{ mL Skittles}}\right) = 0.15\text{ L Skittles}$

(c) $(325.0\text{ g Skittles})\left(\dfrac{1\text{ Skittle}}{1.134\text{ g Skittles}}\right) = 286.6\text{ Skittles}$

(d) $(0.550\text{ L Skittles})\left(\frac{1000\text{ mL Skittles}}{1\text{ L Skittles}}\right)\left(\frac{6\text{ Skittles}}{5.3\text{ mL Skittles}}\right) = 620\text{ Skittles}$

(e) The mass measurement is more precise. It is also more accurate. Using calculations similar to those above there should be 309 Skittles in 350 grams and the average value is 310 Skittles. There should be 367 Skittles in .325 L of Skittles and the average value is 384 Skittles.

59. A graduated cylinder would be the best choice for adding 100 mL of solvent to a reaction. While the volumetric flask is also labeled 100 mL, volumetric flasks are typically used for doing dilutions. The other three pieces of glassware could also be used, but they hold smaller volumes so it would take a longer time to measure out 100 mL. Also, because you would have to repeat the measurement many times using the other glassware, there is a greater chance for error.

60. The conversion is: g → mL

$(21.5\text{ g})\left(\frac{1\text{ mL}}{1.484\text{ g}}\right) = 14.5\text{ mL}$

61. The conversion is: g → mL

$(25.27\text{ g})\left(\frac{1\text{ mL}}{0.97\text{ g}}\right) = 26.05\text{ mL}$

62. The conversion is: day → cups → mg → g → lb

$(1\text{ day})\left(\frac{4.00 \times 10^8\text{ cups}}{\text{day}}\right)\left(\frac{160\text{ mg}}{\text{cup}}\right)\left(\frac{1\text{ g}}{1000\text{ mg}}\right)\left(\frac{1\text{ lb}}{453.6\text{ g}}\right) = 1 \times 10^5\text{ lb}$

63. Mass of gear carried by paladin after drinking strength potion = 115 lb + 50.0 lb = 165 lb
Amount of mass potion paladin can carry = 165 lb − 92 lb = 73 lb

The conversion is: lb → g → mL → vials potion

$(73\text{ lb})\left(\frac{454\text{ g}}{1\text{ lb}}\right)\left(\frac{1\text{ ml}}{193\text{ g}}\right)\left(\frac{1\text{ vial potion}}{50.0\text{ mL}}\right) = 3.43\text{ vials potion}$

You would only be able to collect only 3 vials, because 4 would put you over your mass limit.

64. The conversion is: sequins → cm^3 → g → kg

$(4560\text{ sequins})\left(\frac{0.0241\text{ cm}^3}{1\text{ sequin}}\right)\left(\frac{41.6\text{ g sequins}}{1\text{ cm}^3}\right)\left(\frac{1\text{ kg}}{1000\text{ g}}\right) = 4.57\text{ kg sequins}$

The conversion is: kg → lb

$(4.57\text{ kg sequins})\left(\frac{2.20\text{ lb}}{1\text{ kg}}\right) = 10.1\text{ lb sequins}$

65. $V = \text{side}^3 = (0.50\text{ m})^3 = 0.13\text{ m}^3$ (volume of the cube)

$(0.13\text{ m}^3)\left(\frac{100.\text{ cm}}{\text{m}}\right)^3\left(\frac{1\text{ L}}{1000\text{ cm}^3}\right) = 130\text{ L}$ (volume of cube)

Yes, the cube will hold the solution. 130 L − 8.5 L = 120 L additional solution is necessary to fill the container.

66. The conversion is: $\frac{\mu g}{m^3} \rightarrow \frac{\mu g}{L} \rightarrow \frac{\mu g}{day}$

$$\left(\frac{180\ \mu g}{1\ m^3}\right)\left(\frac{1\ m^3}{1000\ L}\right)\left(2 \times 10^4\ \frac{L}{day}\right) = 4000\ \mu g\ \text{ingested/day} \qquad \text{(1 sig. figure)}$$

Yes, the nurse is at risk. This is well over the toxic limit.

67. (a) Convert 20.27 K to °C

$K - 273.15 = {}^\circ C$

$20.27\ K - 273.15 = -252.88^\circ C$

(b) Convert 20.27 K to °F

${}^\circ F = (1.8 \times {}^\circ C) + 32$

${}^\circ F = (1.8 \times -252.88) + 32 = -455.18 + 32$

${}^\circ F = -423.18^\circ F$

68. ${}^\circ F = 1.8^\circ C + 32$

Convert 36°C to °F $\quad (1.8)(36) + 32 = 97^\circ F$

Convert 38°C to °F $\quad (1.8)(38) + 32 = 100^\circ F$

Sauropods have a body temperature close to the body temperature of other warm-blooded mammals such as dogs, humans, and cows.

69. The conversion is: L → dL → mg → g

$$(4.7\ L)\left(\frac{10\ dL}{1\ L}\right)\left(\frac{130\ mg}{1\ dL}\right)\left(\frac{1\ g}{1000\ mg}\right) = 6.1\ g$$

70. A sample of gold will sink to the bottom of the mercury and a sample of iron pyrite will float.

71. The conversion is: hands → in. → cm → m

$$(14.2\ \text{hands})\left(\frac{4\ \text{in.}}{1\ \text{hand}}\right)\left(\frac{2.54\ cm}{1\ \text{in.}}\right)\left(\frac{1\ m}{100\ cm}\right) = 1.44\ m$$

72. The conversion is: days → hr → gal → qt → L

$$(30\ \text{days})\left(\frac{24\ hr}{1\ day}\right)\left(\frac{22.5\ gal}{12\ hr}\right)\left(\frac{4\ qt}{1\ gal}\right)\left(\frac{0.946\ L}{1\ qt}\right) = 5.1 \times 10^3\ L$$

73. $d = \frac{m}{V}$ The cube with the largest volume has the lowest density. Use Table 2.5.

Cube A - lowest density	1.74 g/mL - magnesium
Cube B	2.70 g/mL - aluminum
Cube C - highest density	10.5 g/mL - silver

74. The conversion is: ft → in. → cm → m → nm → nanotubes

$$(40.0\text{ ft})\left(\frac{12\text{ in.}}{1\text{ ft}}\right)\left(\frac{2.54\text{ cm}}{1\text{ in.}}\right)\left(\frac{1\text{ m}}{100\text{ cm}}\right)\left(\frac{10^9\text{ nm}}{1\text{ m}}\right)\left(\frac{1\text{ nanotube}}{1.3\text{ nm}}\right) = 9.4 \times 10^9\text{ nanotubes}$$

75. The conversion is: acres → ft^2 → mi^2 → km^2

$$(125\text{ acres})\left(\frac{43560\text{ ft}^2}{1\text{ acre}}\right)\left(\frac{1\text{ mi}}{5280\text{ ft}}\right)^2\left(\frac{1.609\text{ km}}{1\text{ mi}}\right)^2 = 0.506\text{ km}^2$$

76. The volume of the aluminum cube is:

$$V = \frac{m}{d} = \frac{500.\text{ g}}{2.70\frac{\text{g}}{\text{mL}}} = 185\text{ mL} \quad \text{Density of Al is } 2.70\text{ g/mL}$$

This is the same volume as the gold cube thus:

$$m = dV = (185\text{ mL})(19.3\text{ g/mL}) = 3.57 \times 10^3\text{ g of gold} \quad \text{Density of Au is } 19.3\text{ g/mL}$$

77. $d = \frac{m}{V} = \frac{24.12\text{ g}}{25.0\text{ mL}} = \frac{0.965\text{ g}}{\text{mL}}$ (density of water at 90°C)

78. $150.50\text{ g} - 88.25\text{ g} = 62.25\text{ g}$ (mass of liquid)

$d = \frac{m}{V}$ thus $V = \frac{m}{d} = \frac{62.25\text{ g}}{1.25\frac{\text{g}}{\text{mL}}} = 49.8\text{ mL}$ (volume of liquid)

The container must hold at least 50 mL.

79. H_2O $\quad \frac{50\text{ g}}{1.0\frac{\text{g}}{\text{mL}}} = 50\text{ mL}$

alcohol $\quad \frac{50\text{ g}}{0.789\frac{\text{g}}{\text{mL}}} = 60\text{ mL}$

Ethyl alcohol has the greater volume due to its lower density.

80. The conversion is: g → lb → oz

$(8.1\text{ g})\left(\frac{1\text{ lb}}{453.6\text{ g}}\right)\left(\frac{16\text{ oz}}{\text{lb}}\right) = 0.29\text{ oz}$ (mass of the coin)

$$(0.29\text{ oz})\left(\frac{3.5\,\%\text{ Mn}}{100}\right) = 0.010\text{ oz Mn}$$

81. Volume of sulfuric acid

$$\left(\frac{1\text{ mL}}{1.84\text{ g}}\right)(100.\text{ g}) = 54.3\text{ mL}$$

82. The conversion is: cup → oz → qt → L → mg

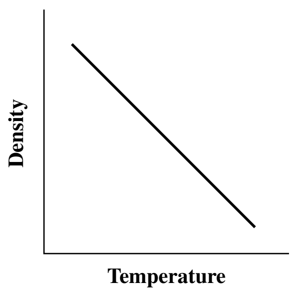
$$(2.00\text{ cup coffee})\left(\frac{10\text{ oz coffee}}{1\text{ cup coffee}}\right)\left(\frac{1\text{ qt coffee}}{32\text{ oz coffee}}\right)\left(\frac{1\text{ L coffee}}{1.057\text{ qt coffee}}\right)\left(\frac{31.4\text{ mg NMP}}{1\text{ L coffee}}\right) = 18.6\text{ mg NMP}$$

83. $$(1.00\text{ kg Pd})\left(\frac{1000\text{ g}}{\text{kg}}\right)\left(\frac{1.00\text{ mL}}{12.0\text{ g}}\right) = 83.3\text{ mL Pd at }20°\text{C}$$

$$(1.00\text{ kg Pd})\left(\frac{1000\text{ g}}{\text{kg}}\right)\left(\frac{1.00\text{ mL}}{11.0\text{ g}}\right) = 90.9\text{ mL Pd at }1550°\text{C}$$

90.9 mL − 83.3 mL = 7.6 mL change in volume

84.



Since $d = \frac{m}{V}$, as the volume increases, the density decreases. As solids are heated the density decreases due to an increase in the volume of the solid.

85. Original Apple computer

$$\left(\frac{\$\,9995}{5.0\text{ Mbytes}}\right)\left(\frac{1\text{ Mbyte}}{10^6\text{ byte}}\right) = \frac{\$2.0\times10^{-3}}{\text{byte}}$$

iPod II

$$\left(\frac{\$\,699}{64\text{ Gbytes}}\right)\left(\frac{1\text{ Gbyte}}{10^9\text{ byte}}\right) = \frac{\$1.1\times10^{-8}}{\text{byte}}$$

The iPod is definitely a better buy!

86. $$\text{V} = (2.00\text{ cm})(15.0\text{ cm})(6.00\text{ cm})\left(\frac{1\text{ mL}}{1\text{ cm}^3}\right) = 180.\text{mL (volume of bar)}$$

$$d = \frac{\text{m}}{\text{V}} = 3300\text{ g}/180.\text{ mL} = 18.3\text{ g/mL}$$

The density of pure gold is 19.3 g/mL (from Table 2.5), therefore, the gold bar is not pure gold, since its density is only 18.3 g/mL, or it is hollow inside.

87. $\text{m} = d\text{V} = (0.789\text{ g/mL})\ (35.0\text{ mL}) = 27.6\text{ g}$ ethyl alcohol

$27.6\text{ g} + 49.28\text{ g} = 76.9\text{ g}$ (mass of cylinder and alcohol)

88. The conversion is g → oz → gr → scruples

$$(695\text{ g})\left(\frac{12\text{ oz}}{373\text{ g}}\right)\left(\frac{480\text{ gr}}{\text{oz}}\right)\left(\frac{1\text{ scruple}}{20\text{ gr}}\right) = 537\text{ scruples}$$

89. The conversion is: days → teaspoons → mL

$$(10\text{ days})\left(\frac{2\text{ teaspoons} \times 4}{\text{day}}\right)\left(\frac{5\text{ mL}}{\text{teaspoon}}\right) = 400\text{ mL}$$

Since you will need a total of 400 mL for the 10 days and the bottle contains 500 mL, you have purchased enough.

90. The density of lead is 11.34 g/mL. The density of aluminum is 2.70 g/mL. The density of silver is 10.5 g/mL. The density of the unknown piece of metal can be calculated from the mass (20.25 g) and the volume (57.5 mL − 50 mL = 7.5 mL) of the metal. Density of the unknown metal = 20.25 g/7.5 mL = 2.7 g/mL. The metal must be aluminum.

91. Volume of slug $30.7\text{ mL} - 25.0\text{ mL} = 5.7\text{ mL}$

Density of slug $d = \frac{\text{m}}{\text{V}} = \frac{15.454\text{ g}}{5.7\text{ mL}} = 2.7\text{ g/mL}$

Mass of liquid, cylinder, and slug	125.934 g
Mass of slug(subtract)	−15.454 g
Mass of cylinder(subtract)	−89.450 g
Mass of the liquid	21.030 g

Density of liquid $d = \frac{\text{m}}{\text{V}} = \frac{21.030\text{ g}}{25.0\text{ mL}} = 0.841\text{ g/mL}$

92. The conversion is: km → m → cm → in. → ft → mi → hr → min → s → ns

$$(730.0\text{ km})\left(\frac{1000\text{ m}}{1\text{ km}}\right)\left(\frac{100\text{ cm}}{1\text{ m}}\right)\left(\frac{1\text{ in.}}{2.54\text{ cm}}\right)\left(\frac{1\text{ ft}}{12\text{ in.}}\right)\left(\frac{1\text{ mi}}{5280\text{ ft}}\right)\left(\frac{1\text{ hr}}{1.86 \times 10^8\text{ mi}}\right)\left(\frac{60\text{ min}}{1\text{ hr}}\right)\left(\frac{60\text{ s}}{1\text{ min}}\right)\left(\frac{10^9\text{ ns}}{1\text{ s}}\right) = 8.78 \times 10^6\text{ ns}$$

8780000 ns is good to only 3 sig figs. You would need at least 6 significant digits to detect the difference between 8780000 ns and (8780000 + 60) ns. Sometimes experimenters do not see differences due to the precision of their measuring techniques.