Uncertainty in Measurement

1.31 Exact: (c), (d), and (f) (All others depend on measurements and standards that have margins of error, e.g., the length of a week as defined by the earth's rotation.)

1.32 Exact: (b), (e) (The number of students is exact on any given day.)

1.33 7.5 cm. There are two significant figures in this measurement; the number of cm can be read precisely but there is some estimating (uncertainty) required to read tenths of a centimeter. Two significant figures is consistent with the convention that measured quantities are reported so that there is uncertainty in only the last digit.

1.34 140°C. The temperature can be read to the nearest 50°C and estimated to the nearest 5-10°C. Since there is uncertainty in the tens digit, the measurement has two significant figures.

1.35 (a) 4 (b) 3 (c) 4 (d) 3 (e) 5

1.36 (a) 4 (b) 3 (c) 4 (d) 5 (e) 6

1.37 (a) 3.002×10^{2} (b) 4.565×10^{5} (c) 6.543×10^{-3}
(d) 9.578×10^{-4} (e) 5.078×10^{4} (f) -3.500×10^{-2}

1 Matter and Measurement — Solutions to Exercises

1.38 (a) 1.44×10^{5} (b) 9.75×10^{-2} (c) 8.90×10^{5}
(d) 6.76×10^{4} (e) 3.40×10^{4} (f) -6.56

1.39 (a) 27.04 (b) -8.0 (c) 1.84×10^{-3} (d) 7.66×10^{-4}

1.40 (a) -2.3×10^{3} (The intermediate result has 2 significant figures, so only the thousand and hundred places in the answer are significant.)

(b) $[285.3 \times 10^{5} - 0.01200 \times 10^{5}] \times 2.8954 = 8.260 \times 10^{7}$ (Since subtraction depends on decimal places, both numbers must have the same exponent to determine decimal places/sig figs. The intermediate result has 1 decimal place and 4 sig figs, so the answer has 4 sig figs)

(c) $(0.0045 \times 20{,}000.0) + (2813 \times 12) = 3.4 \times 10^{4}$
2 sig figs /0 dec pl 2 sig figs /first 2 digits

(d) $863 \times [1255 - (3.45 \times 108)] = 7.62 \times 10^{5}$
3 sig figs /0 dec pl
3 sig figs × 0 dec pl/3 sig figs = 3 sig figs

Dimensional Analysis

1.41 In order to cancel units, the conversion factor must have the unit being canceled opposite the starting position. For example, if the unit cm starts in the numerator, then the conversion factor must have cm in its denominator. However, if the unit cm starts in the denominator, the conversion factor must have cm in the numerator. Ideally, this will lead to the desired units in the appropriate location, numerator or denominator. However, the inverse of the answer can be taken when necessary.

1.42 (a) $\frac{1.6093\ \text{km}}{1\ \text{mi}}$; when converting miles to kilometers, miles goes in the denominator so that it cancels the original unit, leaving km in the numerator.

(b) $\frac{453.59\ \text{g}}{16\ \text{oz}} = \frac{28.349\ \text{g}}{1\ \text{oz}}$ (c) $\frac{1\ \text{L}}{1.0567\ \text{qt}}$

2.8 (a) The droplets contain different charges because there may be 1, 2, 3 or more excess electrons on the droplet.

(b) The electronic charge is likely to be the lowest common factor in all the observed charges.

(c) Assuming this is so, we calculate the apparent electronic charge from each drop as follows:

A: $1.60 \times 10^{-19} / 1 = 1.60 \times 10^{-19}$ C

B: $3.15 \times 10^{-19} / 2 = 1.58 \times 10^{-19}$ C

C: $4.81 \times 10^{-19} / 3 = 1.60 \times 10^{-19}$ C

D: $6.31 \times 10^{-19} / 4 = 1.58 \times 10^{-19}$ C

The reported value is the average of these four values. Since each calculated charge has three significant figures, the average will also have three significant figures.

$(1.60 \times 10^{-19}\ \text{C} + 1.58 \times 10^{-19}\ \text{C} + 1.60 \times 10^{-19}\ \text{C} + 1.58 \times 10^{-19}\ \text{C}) / 4 = 1.59 \times 10^{-19}\ \text{C}$

2.16 (a) ^{32}P has 15 p, 17 n (b) ^{51}Cr has 24 p, 27 n (c) ^{60}Co has 27 p, 33 n

(d) ^{99}Tc has 43 p, 56 n (e) ^{131}I has 53 p, 78 n (f) ^{201}Tl has 81 p, 120 n

2.26 (a) The purpose of the magnet in the mass spectrometer is to change the path of the moving ions. The magnitude of the deflection is inversely related to mass, which is the basis of the discrimination by mass.

(b) The atomic weight of Cl, 35.5, is an average atomic mass. It is the average of the masses of two naturally occurring isotopes, weighted by their abundances. See Solution 2.21(b).

(c) The single peak at mass 31 in the mass spectrum of phosphorus indicates that the sample contains a single isotope of P, and the mass of this isotope is 31 amu.

2.34 Compounds with the same empirical but different molecular formulas differ by the integer number of empirical formula units in the respective molecules. Thus, they can have very different molecular structure, size and mass, resulting in very different physical properties.

2.42 CH: C_2H_2, C_6H_6

CH_2: C_2H_4, C_3H_6, C_4H_8

NO_2: N_2O_4, NO_2

2.46 (a) AgI (b) Ag_2S (c) AgF

2.54 (a) lithium oxide (b) iron(III) carbonate (ferric carbonate)
(c) sodium hypochlorite (d) ammonium sulfite (e) strontium cyanide
(f) chromium(III) hydroxide (chromic hydroxide) (g) cobalt(II) nitrate (cobaltous nitrate)
(h) sodium dihydrogen phosphate (i) potassium permanganate (j) silver dichromate

2.55 (a) Cu_2O (b) K_2O_2 (c) $Al(OH)_3$ (d) $Zn(NO_3)_2$ (e) Hg_2Br_2 (f) $Fe_2(CO_3)_3$ (g) NaBrO

2.56 (a) $K_2Cr_2O_7$ (b) $Co(NO_3)_2$ (c) $Cr(C_2H_3O_2)_3$ (d) NaH (e) $Ca(HCO_3)_2$
(f) $Ba(BrO_3)_2$ (g) $Cu(ClO_4)_2$