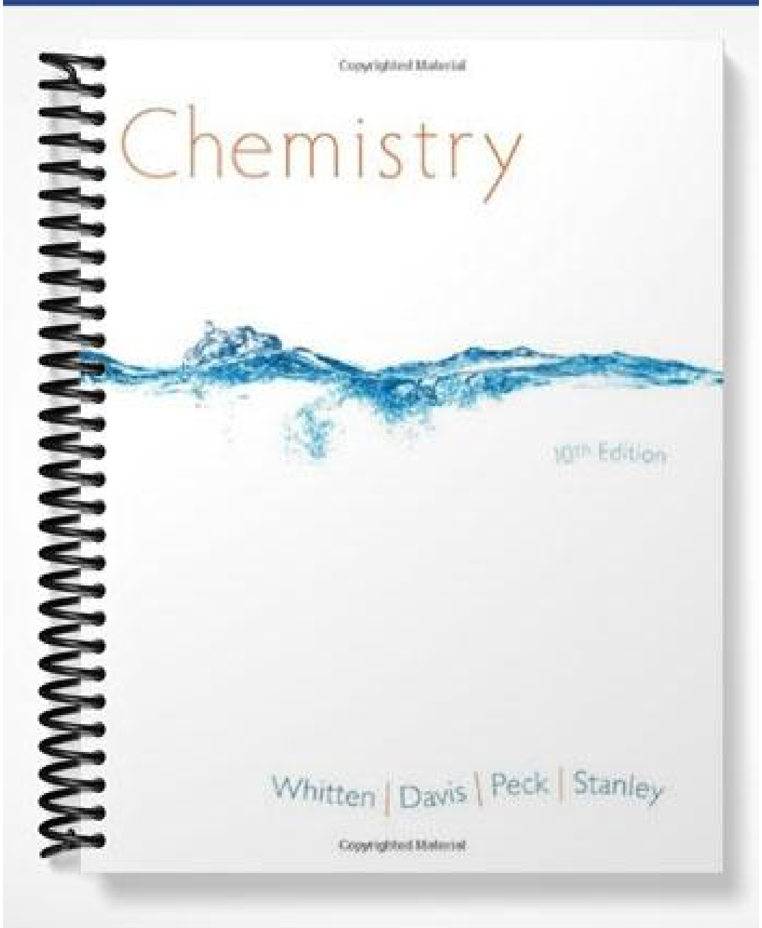
SOLUTIONS MANUAL



2 Chemical Formulas and Composition Stoichiometry

2-1 (a) Stoichiometry is the description of the quantitative relationships among elements in a compound and among substances as they undergo chemical change.

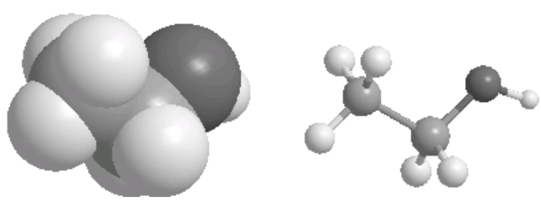
(b) Composition stoichiometry describes the quantitative relationships among elements in compounds, e.g., in water, H_2O, there are 2 hydrogen atoms for every 1 atom of oxygen. Reaction stoichiometry describes the quantitative relationships among substances as they undergo chemical changes. (Reaction stoichiometry will be discussed in Chapter 3.)

2-3 The common ions for each formula unit is listed below:

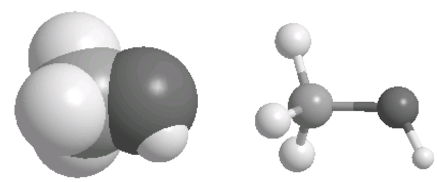
(a) $MgCl_2$ contains Mg^{2+} and Cl^- ions (b) $(NH_4)_2CO_3$ contains NH_4^+ and CO_3^{2-} ions

(c) $Zn(NO_3)_2$ contains Zn^{2+} and NO_3^- ions

2-5 Ethanol -CH_3CH_2OH Methanol-CH_3OH



(space-filling; ball-and-stick)

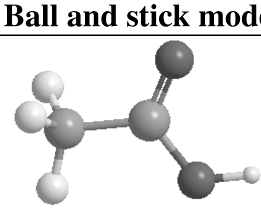
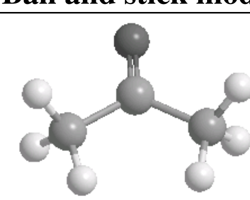
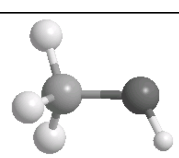
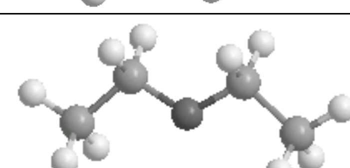


(space-filling; ball-and-stick)

Both are composed of hydrogen, carbon, and oxygen. Both have an oxygen and hydrogen on the end. The ethanol molecule has an additional carbon and two hydrogens.

2-7 Organic compounds are those that contain carbon-to-carbon bonds, carbon-to-hydrogen bonds, or both. Organic formulas given in Table 2-1 include: acetic acid- CH_3COOH, methane- CH_4, ethane- C_2H_6, propane- C_3H_8, butane- C_4H_{10}, pentane- C_5H_{12}, benzene- C_6H_6, methanol- CH_3OH, ethanol- CH_3CH_2OH, acetone- CH_3COCH_3, diethyl ether- $CH_3CH_2COCH_2CH_3$.

2-9 Compounds from Table 2-1 that contain only carbon and hydrogen and are not shown in Figure 1-5:

Compound	**Ball and stick model**	**Compound**	**Ball and stick model**
acetic acid- CH_3COOH		acetone- CH_3COCH_3	
methanol- CH_3OH		diethyl ether- $CH_3CH_2COCH_2CH_3$	

2-11 (a) Formula weight is the mass in atomic mass units of the simplest formula of an ionic compound and is found by adding the atomic weights of the atoms specified in the formula. The numerical amount for the formula weight is the equal to the numerical amount for the mass in grams of one mole of the substance.
(b) Molecular weight is the mass in atomic mass units of one molecule of a substance that is molecular, rather than ionic. It is found by adding the atomic weights of the atoms specified in the formula. The numerical amount for the molecular weight is the equal to the numerical amount for the mass in grams of one mole of the substance.
(c) Structural formula is the representation that shows how atoms are connected in a compound.
(d) An ion is an atom or group of atoms that carries an electrical charge, which is caused by unequal numbers of protons and electrons. A postive ion is a cation. A negative ion is an anion.

2-13 The formulas for (a) through (d) are given in Table 2-1.
(a) C_4H_{10} (b) CH_3CH_2OH (c) SO_3 (d) CH_3COCH_3 (e) CCl_4

2-15 We can find most of the names of the appropriate ions in Table 2-2.
(a) magnesium chloride (b) iron(II) nitrate (c) sodium sulfate
(d) calcium hydroxide (e) iron(II) sulfate

2-17 Formulas are written to show the ions in the smallest ratio that gives no net charge. Compounds are electrically neutral.
(a) NaOH, sodium hydroxide (b) $Al_2(CO_3)_3$, aluminum carbonate
(c) Na_3PO_4, sodium phosphate (d) $Ca(NO_3)_2$, calcium nitrate
(e) $FeCO_3$, iron(II) carbonate

2-19 (a) This chemical formula is incorrect. The atomic symbol for a potassium ion is K^+, not P^+. The correct chemical formula for potassium iodide is KI.
(b) This chemical formula is correct.
(c) The chemical formula is incorrect. The symbol for a silver ion is Ag^+. The correct chemical formula for the carbonate ion is CO_3^{2-}. Therefore, the chemical formula for silver carbonate is Ag_2CO_3.

2-21 (a) $Al(OH)_3$ (b) $MgCO_3$ (c) $ZnCO_3$ (d) $(NH_4)_2SO_4$ (e) $ZnSO_4$

2-23 (a) $CaCO_3$ (b) $Mg(OH)_2$ (c) CH_3COOH (d) NaOH (e) ZnO

2-25 $\frac{?\ \text{amu}}{\text{atom}} \geq 58.693 \times 2 \geq 117.386$ amu/atom **.** The atomic weight of tin is 118.710 amu/atom.

Tin, Sn, is the element with an atomic weight slightly over 117.386 amu.

2-27 (a) *amu*—a measurement of mass that is equal to exactly 1/12 of the mass of an atom of carbon-12.
(b) The mass of an atom of cobalt is almost twice that of an atom of aluminum (58.93/26.98).

2-29 Here we use the atomic weights to the number of places given in the periodic table in the inside front cover of the text.

(a)

1 x Ca	= 1 x 40.078	amu =	40.078	amu
1 x S	= 1 x 32.066	amu =	32.066	amu
4 x O	= 4 x 15.9994	amu =	63.9976	amu
		FW =	**136.142amu**	

(b)

3 x C	= 3 x 12.011	amu =	36.033	amu
8 x H	= 8 x 1.0079	amu =	8.0632	amu
		FW =	**44.096amu**	

(c)

6 x C	= 6 x 12.011	amu =	72.066	amu
8 x H	= 8 x 1.0079	amu =	8.0632	amu
1 x S	= 1 x 32.066	amu =	32.066	amu
2 x O	= 2 x 15.9994	amu =	31.9988	amu
2 x N	= 2 x 14.0067	amu =	28.0134	amu
		FW =	**172.207amu**	

(d)

3 x U	= 3 x 238.0289	amu =	714.0867	amu
14 x O	= 14 x 15.9994	amu =	223.9916	amu
2 x P	= 2 x 30.9738	amu =	61.9476	amu
		FW =	**1000.0259amu**	

2-31 The ratio of masses present is $\frac{1.76 \text{ g Ba}}{0.487 \text{ g F}} = 3.614$ or $\frac{3.614 \text{ g Ba}}{1.0 \text{ g F}}$. Based on the formula BaF_2, this ratio represents $\frac{1 \text{ atom Ba}}{2 \text{ atoms F}}$. So the atomic mass ratio of Ba/F is $\frac{\text{AW Ba}}{\text{AW F}}$ or $\frac{3.614}{1.0/2} = \boxed{7.228}$

From a table of atomic weights, $\frac{\text{AW Ba}}{\text{AW F}} = \frac{137.33 \text{ amu}}{19.00 \text{ amu}} = \boxed{7.228}$

This calculation could not be done without knowledge of the formula or some other knowledge of the relative numbers of atoms present.

2-33 $\underline{?} \text{ g } H_2O_2 = 1.24 \text{ mol } H_2O_2 \times \frac{34.02 \text{ g } H_2O_2}{1 \text{ mol } H_2O_2} = \boxed{42.2 \text{ g } H_2O_2}$

2-35 (a) $\underline{?} \text{ Formula Units } K_2CrO_4 = 154.3 \text{ g } K_2CrO_4 \times \frac{1 \text{ mol } K_2CrO_4}{194.20 \text{ g } K_2CrO_4}$

$$\times \frac{6.022 \times 10^{23} \text{ For. Units } K_2CrO_4}{1 \text{ mol } K_2CrO_4} = \boxed{4.785 \times 10^{23} \text{ Form. Units } K_2CrO_4}$$

(b) $\underline{?} \text{ } K^+ \text{ ions} = 4.785 \times 10^{23} \text{ Formula Units } K_2CrO_4 \times \frac{2 \text{ } K^+ \text{ ions}}{1 \text{ For. unit } K_2CrO_4} =$

$$\boxed{9.570 \times 10^{23} \text{ } K^+ \text{ ions}}$$

(c) ? CrO_4^{2-} ions = 4.785×10^{23} Formula Units K_2CrO_4 x $\dfrac{1\ CrO_4^{2-}\text{ ion}}{1\text{ For. Unit }K_2CrO_4}$ =

$$\boxed{4.785 \times 10^{23}\ CrO_4^{2-}\text{ ions}}$$

(d) Each formula unit contains 2 K, 1 Cr, and 4 O atoms, or 7 atoms total.

? atoms = 4.785×10^{23} Formula units K_2CrO_4 x $\dfrac{7\text{ atoms}}{1\text{ For. Unit }K_2CrO_4}$ = $\boxed{3.350 \times 10^{24}\text{ atoms}}$

2-37 $\dfrac{6.438\text{ g Ne}}{20.1797\text{ g Ne per mole}} = \boxed{0.3190\text{ mole Ne}}$

2-39 (a) No. The molecular formulas are different, so the mass of one mole of molecules (the molar mass) is different.
(b) Yes. One mole of any kind of molecules contains Avogadro's number of molecules.
(c) No. This is for the same reason given in (a).
(d) No. The formulas are different, so there are different numbers of atoms per molecule and, hence, different total numbers of atoms in equal numbers of molecules.

2-41 Here we show values in the table on the right front inside cover. The bolded amounts represents the amounts the students fill in.

	Element	**Formula**	**Mass of one mole of molecules**
(a)	Br	Br_2	**159.808 g**
(b)	**O**	O_2	**31.9988 g**
(c)	**P**	P_4	**123.8952 g**
(d)	**Ne**	**Ne**	20.1797 g
(e)	S	$\mathbf{S_8}$	256.53 g
(f)	O	$\mathbf{O_2}$	**31.9988 g**

2-43 ? g/atom Cu = $\dfrac{63.546\text{ g Cu}}{1\text{ mol Cu}} \times \dfrac{1\text{ mol Cu}}{6.022 \times 10^{23}\text{ atoms Cu}} = \boxed{1.055 \times 10^{-22}\text{ g/ 1 atom Cu}}$

2-45 ? molecules C_3H_8 = 8.00×10^6 molecules CH_4 x $\dfrac{1\text{ mol }CH_4}{6.022 \times 10^{23}\text{ molecules }CH_4} \times \dfrac{16.043\text{ g }CH_4}{1\text{ mol }CH_4}$

$$\frac{1\text{ mol }CH_4}{1\text{ mol }C_3H_8} \times \frac{1\text{ mol }C_3H_8}{44.096\text{ g }C_3H_8} \times \frac{6.022 \times 10^{23}\text{ molecules }C_3H_8}{\text{mol }C_3H_8} = \boxed{2.91 \times 10^6\text{ molecules }C_3H_8}$$

2-47 FW $Fe_3(PO_4)_2$ = 357.49 amu

$$\%\ Fe = \frac{3 \times 55.85\text{ amu Fe}}{357.49\text{ amu}} \times 100\% = \boxed{46.8\%\ Fe}$$

2-49

Element	Mass of Element	Moles of Element	Divide by Smallest
C	60.00	$\frac{60.00}{12.011} = 4.995$ mol	$\frac{4.995}{1.667} = 3.00$
H	13.33	$\frac{13.33}{1.0079} = 13.23$ mol	$\frac{13.23}{1.667} = 7.94$
O	26.67	$\frac{26.67}{15.9994} = 1.667$ mol	$\frac{1.667}{1.667} = 1.00$
	Total 100.00		

Smallest Whole-Number Ratio of Atoms is C_3H_8O, the simplest formula.

Formula weight of simplest formula = 60 amu.

Since the formula weight of the simplest formula (FW = 60.09 amu) is equal to the approximate molecular weight given, the molecular formula is the simplest formula, $\boxed{C_3H_8O}$

2-51 (a) % O = 100 % total – [9.79% H + 79.12% C] = 11.09% O

$$\text{So, MW} = \frac{2 \times 16.00 \text{ amu} \times 100}{11.09} = \boxed{288.5 \text{ amu}}$$

(b) % O = 100 % total – [9.79% H + 79.12% C] = 11.09% O

Element	Rel. Mass Element	Rel. No. of Atoms	Divide by Smallest	Multiply by 2
C	79.12	$\frac{79.12}{12.011} = 6.588$	$\frac{6.588}{0.6934} = 9.50$	19
H	9.79	$\frac{9.79}{1.0079} = 9.71$	$\frac{9.71}{0.6934} = 14.00$	28
O	11.09	$\frac{11.09}{15.994} = 0.6934$	$\frac{.6934}{0.6934} = 1.00$	2
	Total 100.00			

The simplest formula is $C_{19}H_{28}O_2$. Given that each molecule contains two O atoms, the molecular formula is $\boxed{C_{19}H_{28}O_2}$. As a check on the MW calculated above, the MW of this formula is 288.2.

2-53 (a)

Element	**Rel. Mass Element**	**Rel. No. of Atoms**	**Divide by Smallest**
Cu	30.03	$\frac{30.03}{63.55} = 0.4725$	$\frac{0.4725}{0.4725} = 1.00$
C	22.70	$\frac{22.70}{12.011} = 1.890$	$\frac{1.890}{0.4725} = 4.00$
H	1.91	$\frac{1.91}{1.008} = 1.895$	$\frac{1.895}{0.4725} = 4.01$
O	45.37	$\frac{45.37}{16.00} = 2.836$	$\frac{2.836}{0.4725} = 6.00$
	Total 100.00		

The simplest formula is $\boxed{CuC_4H_4O_6}$

(b)

Element	**Rel. Mass Element**	**Rel. No. of Atoms**	**Divide by Smallest**
N	11.99	$\frac{11.99}{14.01} = 0.8558$	$\frac{0.8558}{0.8557} = 1.00$
O	13.70	$\frac{13.70}{16.00} = 0.8563$*	$\frac{0.8563}{0.8557} = 1.00$
B	9.25	$\frac{9.25}{10.81} = 0.8557$	$\frac{0.8557}{0.8557} = 1.00$
F	65.06	$\frac{65.06}{19.00} = 3.424$	$\frac{3.424}{0.8557} = 4.00$
	Total 100.00		

The simplest formula is $\boxed{NOBF_4}$

*More significant digits can be kept throughout the problem and rounded for the final answer.

2-55 (a)

Element	**Mass of Element**	**Rel. No. of Atoms**	**Divide by Smallest**
N	5.60	$\frac{5.60}{14.01} = 0.400$	$\frac{0.400}{0.400} = 1.00$
Cl	14.2	$\frac{14.2}{35.45} = 0.401$	$\frac{0.401}{0.400} = 1.00$
H	0.800	$\frac{0.800}{1.01} = 0.792$	$\frac{0.792}{0.400} = 1.98 \approx 2$

The simplest formula is $\boxed{NClH_2 \text{ or } NH_2Cl}$

(b)

Element	Rel. Mass Element	Rel. No. of Atoms	Divide by Smallest
N	26.2	$\frac{26.2}{14.01} = 1.87$	$\frac{1.87}{1.87} = 1.00$
Cl	66.4	$\frac{66.4}{35.45} = 1.87$	$\frac{1.87}{1.87} = 1.00$
H	7.5	$\frac{7.5}{1.01} = 7.43$*	$\frac{7.43}{1.87} = 3.97 \approx 4$
	Total 100.00		

The simplest formula is $\boxed{NClH_4 \text{ or } NH_4Cl}$

*More significant digits can be kept throughout the problem and rounded for the final answer.

2-57

Element	Rel. Mass Element	Rel. No. of Atoms	Divide by Smallest
C	65.13	$\frac{65.13}{12.01} = 5.423$	$\frac{5.422}{0.417} = 13.00$
H	7.57	$\frac{7.57}{1.008} = 7.51$	$\frac{7.51}{0.417} = 18.01$
Cl	14.79	$\frac{14.79}{35.45} = 0.4172$	$\frac{0.4172}{0.417} = 1.00$
N	5.84	$\frac{5.84}{14.01} = 0.417$	$\frac{0.417}{0.417} = 1.00$
O	6.67	$\frac{6.67}{16.00} = 0.417$	$\frac{0.417}{0.417} = 1.00$
	Total 100.00		

The simplest formula is $\boxed{C_{13}H_{18}ClNO}$

2-59

Element	Rel. Mass Element	Rel. No. of Atoms	Divide by Smallest
C	67.30	$\frac{67.30}{12.01} = 5.604$	$\frac{5.604}{0.330} = 17.00$
H	6.930	$\frac{6.930}{1.008} = 6.875$	$\frac{6.875}{0.330} = 20.83 \approx 21$
O	21.15	$\frac{21.15}{16.00} = 1.322$	$\frac{1.322}{0.330} = 4.01$
N	4.62	$\frac{4.62}{14.01} = 0.330$	$\frac{0.330}{0.330} = 1.00$
	Total 100.00		

The simplest formula is $\boxed{C_{17}H_{21}O_4N}$

2-61 (a) FW $C_{14}H_{18}N_2O_5$ = 294.34 amu

$$\% C = \frac{14 \times 12.011 \text{ amu C}}{294.34 \text{ amu}} \times 100\% = \boxed{57.13\%\ C}$$

$$\% H = \frac{18 \times 1.01 \text{ amu H}}{294.34 \text{ amu}} \times 100\% = \boxed{6.18\%\ H}$$

$$\% N = \frac{2 \times 14.01 \text{ amu N}}{294.34 \text{ amu}} \times 100\% = \boxed{9.520\%\ N}$$

$$\% O = \frac{5 \times 16.00 \text{ amu O}}{294.34 \text{ amu}} \times 100\% = \boxed{27.18\%\ O}$$

(b) FW SiC = 40.097 amu

$$\% Si = \frac{1 \times 28.086 \text{ amu Si}}{40.097 \text{ amu}} \times 100\% = \boxed{70.05\%\ Si}$$

$$\% C = \frac{1 \times 12.011 \text{ amu C}}{40.097 \text{ amu}} \times 100\% = \boxed{29.95\%\ C}$$

(c) FW $C_9H_8O_4$ = 180.17 amu

$$\% C = \frac{9 \times 12.01 \text{ amu C}}{180.17 \text{ amu}} \times 100\% = \boxed{59.99\%\ C}$$

$$\% H = \frac{8 \times 1.01 \text{ amu H}}{180.17 \text{ amu}} \times 100\% = \boxed{4.48\%\ H}$$

$$\% O = \frac{4 \times 16.00 \text{ amu O}}{180.17 \text{ amu}} \times 100\% = \boxed{35.52\%\ O}$$

2-63 (a) Hydrogen peroxide's actual formula is H_2O_2; however, its simplest formula or lowest whole number ratio is HO.

(b) Water's actual formula is H_2O, while its simplest formula is also H_2O.

(c) Ethylene glycol's actual formula is $C_2H_6O_2$; however, its simplest formula is CH_3O.

2-65

$$\underline{?}\text{g C} = 2.92 \text{ g } CO_2 \times \frac{12.01 \text{ g C}}{44.010 \text{ g } CO_2} = 0.797 \text{ g C}$$

$$\underline{?}\text{g H} = 1.22 \text{ g } H_2O \times \frac{2(1.008 \text{ g H})}{18.0152 \text{ g } H_2O} = 0.137 \text{ g H}$$

$$\underline{?}\text{g O} = 1.20 \text{ g} - 0.797 \text{ g} - 0.137 \text{ g} = 0.27 \text{ g O}$$

Element	**Mass of Element**	**Rel. No. of Atoms**	**Divide by Smallest**
C	0.797	$\frac{0.797}{12.01} = 0.0664$	$\frac{0.0664}{0.0169} = 3.93 \approx 4$
H	0.137	$\frac{0.137}{1.008} = 0.136$	$\frac{0.136}{0.0169} = 8.05$
O	0.27	$\frac{0.27}{16.00} = 0.0169$	$\frac{0.0169}{0.0169} = 1.00$

The simplest formula is $\boxed{C_4H_8O}$

2-67

$$\underline{?}\text{mol C} = 4.839 \text{ g } CO_2 \times \frac{12.011 \text{ g C}}{44.010 \text{ g } CO_2} = 1.321 \text{ g C}$$

$$\underline{?}\text{g H} = 3.959 \text{ g } H_2O \times \frac{2(1.0079 \text{ g H})}{18.0152 \text{ g } H_2O} = 0.4430 \text{ g H}$$

$$\underline{?}\text{g N} = 3.302 \text{ g} - (1.321 + 0.4430) = 1.538 \text{ g N}$$

Element	**Mass of Element**	**Rel. No. of Atoms**	**Divide by Smallest**
C	1.321	$\frac{1.321}{12.01} = 0.1100$	$\frac{0.1100}{0.1098} = 1.002 \approx 1$
H	0.4430	$\frac{0.4430}{1.008} = 0.4395$	$\frac{0.4395}{0.1098} = 4.003 \approx 4$
N	1.538	$\frac{1.538}{14.0067} = 0.1098$	$\frac{0.1098}{0.1098} = 1.00$

The simplest formula is $\boxed{CH_4N}$, which has a molar mass of 30.049 g/mol

The actual substance has a molar mass of 60.10 g/mol $\frac{60.10}{30.049} = 2$

The molecular formula is $\boxed{C_2H_8N_2}$,

2-69 $\underline{?}$ g Mg = 0.104 g MgO x $\frac{24.3 \text{ g Mg}}{40.31 \text{ g MgO}}$ = 0.0627 g Mg

$\underline{?}$ g H = 0.0231 g H_2O x $\frac{2 \times 1.01 \text{ g H}}{18.02 \text{ g } H_2O}$ = 0.00259 g H

$\underline{?}$ g Si = 0.155 g SiO_2 x $\frac{28.1 \text{ g Si}}{60.1 \text{ g } SiO_2}$ = 0.0725 g Si

$\underline{?}$ g O = 0.301 g total – [0.0627 g Mg + 0.00259 g H + 0.0725 g Si] = 0.163 g O

Element	**Mass of Element**	**Rel. No. of Atoms**	**Divide by Smallest**
Mg	0.0627	$\frac{0.0627}{24.3}$ = 0.00258	$\frac{0.00258}{0.00258}$ = 1.00
H	0.00259	$\frac{0.00259}{1.01}$ = 0.00256	$\frac{0.00256}{0.00258}$ = 1.00
Si	0.0725	$\frac{0.0725}{28.1}$ = 0.00258	$\frac{0.00258}{0.00258}$ = 1.00
O	0.163	$\frac{0.163}{16.00}$ = 0.0102	$\frac{0.0102}{0.00258}$ = 3.96 ≈ 4

The simplest formula is $\boxed{MgHSiO_4}$

2-71 Calculate the amount of O for a given amount of H in each compound:

In H_2O: $\frac{1 \times 16.00 \text{ amu O}}{2 \times 1.01 \text{ amu H}}$ = 7.92 amu O/amu H

In H_2O_2: $\frac{2 \times 16.00 \text{ amu O}}{2 \times 1.01 \text{ amu H}}$ = 15.84 amu O/amu H

The mass of O in these two compounds is in the ratio 7.92 : 15.84 or 1 : 2. The masses of O that combine with a fixed mass of H in the two compounds are in the ratio of small whole numbers, 1 : 2. Alternatively, the masses of H that combine with a fixed mass of O could be compared.

2-73 If the M_2O substance is 73.4% M by mass, then it is 26.6% Oxygen by mass.

This means that if you had one mole of M_2O: $26.6 = \frac{15.9994 \text{ g O}}{x \text{ g } M_2O} \times 100$

or that 60.148 would be the grams of M_2O in a mole.

60.148 – 15.9994 = 44.15 as the mass of the 2 M atoms; each M is 22.07 g/mol

So for MO: $\underline{?}$ % M in MO = $\frac{22.07 \text{ g M}}{22.07 + 15.9994 \text{ g MO}}$ x 100 = 58.0 % M in MO

2-75 Note: The mass (or weight) ratio in *any* units is the same as that deduced in amus or grams, e.g.,

$$\frac{63.55 \text{ amu Cu}}{183.54 \text{ amu CuFeS}_2} \text{ or } \frac{63.55 \text{ lb Cu}}{183.54 \text{ lb CuFeS}_2}$$

$$\underline{?} \text{ lb Cu} = 6.63 \text{ lb CuFeS}_2 \text{ x } \frac{63.55 \text{ lb Cu}}{183.54 \text{ lb CuFeS}_2} = 2.2956 = \boxed{2.30 \text{ lb Cu}}$$

2-77 (a) FW $CuSO_4$ = 159.62 amu

$$\underline{?} \text{ g Cu} = 253 \text{ g CuSO}_4 \text{ x } \frac{63.55 \text{ g Cu}}{159.62 \text{ g CuSO}_4} = \boxed{101 \text{ g Cu}}$$

(b) FW $CuSO_4{\cdot}5H_2O$ = 249.72

$$\underline{?} \text{ g Cu} = 573 \text{ g CuSO}_4{\cdot}5\text{H}_2\text{O x } \frac{63.55 \text{ g Cu}}{249.72 \text{ g CuSO}_4{\cdot}5\text{H}_2\text{O}} = \boxed{146 \text{ g Cu}}$$

2-79

$$\underline{?} \text{ g Cu}_3(\text{CO}_3)_2(\text{OH})_2 = 685 \text{ g Cu x } \frac{344.69 \text{ g Cu}_3(\text{CO}_3)_2(\text{OH})_2}{3 \text{ x } 63.55 \text{ g Cu}} = \boxed{1.24 \text{ x } 10^3 \text{ g Cu}_3(\text{CO}_3)_2(\text{OH})_2}$$

2-81 Formula weights: $CaWO_4$ = 287.93; $FeWO_4$ = 303.70

$$\underline{?} \text{ g CaWO}_4 = 657 \text{ g FeWO}_4 \text{ x } \frac{183.85 \text{ g W}}{303.70 \text{ g FeWO}_4} \text{ x } \frac{287.93 \text{ g CaWO}_4}{183.85 \text{ g W}} = \boxed{623 \text{ g CaWO}_4}$$

2-83

$$\underline{?} \text{ g Pb} = 110.5 \text{ g ore x } \frac{10.0 \text{ g PbS}}{100.0 \text{ g ore}} \text{ x } \frac{207.2 \text{ g Pb}}{239.26 \text{ g PbS}} = \boxed{9.569 \text{ g Pb/110.5 g ore}}$$

2-85

$$\underline{?} \text{ g Sr(NO}_3)_2 = 267.7 \text{ g sample x } \frac{88.2 \text{ g Sr(NO}_3)_2}{100.0 \text{ g sample}} = 236.1 \text{ g Sr(NO}_3)_2 \text{ present}$$

The formula weight of $Sr(NO_3)_2$ is 211.63 g/mol.

(a) $$\underline{?} \text{ g Sr} = 236.1 \text{ g Sr(NO}_3)_2 \text{ x } \frac{87.62 \text{ g Sr}}{211.63 \text{ g Sr(NO}_3)_2} = \boxed{97.75 \text{ g Sr}}$$

(b) $$\underline{?} \text{ g N} = 236.1 \text{ g Sr(NO}_3)_2 \text{ x } \frac{2 \text{ x } 14.0 \text{ g N}}{211.63 \text{ g Sr(NO}_3)_2} = \boxed{31.24 \text{ g N}}$$

2-87 (a) $$\underline{?} \text{ g CH}_3\text{COOH} = 143.7 \text{ g vinegar x } \frac{5.0 \text{ g CH}_3\text{COOH}}{100 \text{ g vinegar}} = \boxed{7.2 \text{ g CH}_3\text{COOH}}$$

(b) $$\underline{?} \text{ lb CH}_3\text{COOH} = 143.7 \text{ lb vinegar x } \frac{5.0 \text{ lb CH}_3\text{COOH}}{100 \text{ lb vinegar}} = \boxed{7.2 \text{ lb acetic acid}}$$

(c) $$\underline{?} \text{ g NaCl} = 34.0 \text{ g solution x } \frac{5.0 \text{ g NaCl}}{100 \text{ g solution}} = \boxed{1.7 \text{ g NaCl}}$$

2-89 Assume you spend one dollar to purchase each substance. To get the lb of nitrogen per dollar:

$$\frac{?\ \text{lb}\ (NH_4)_2SO_4}{\$} = \frac{20\ \text{lb}\ (NH_4)_2SO_4}{\$\ 7.00} \times \frac{2 \times 14.01\ \text{lb N}}{132.15\ \text{lb}\ (NH_4)_2SO_4} = \boxed{0.6058\ \text{lb N per dollar for}\ (NH_4)_2SO_4}$$

$$\frac{?\ \text{lb}\ CH_4N_2O}{\$} = \frac{6\ \text{lb}\ CH_4N_2O}{\$\ 21.00} \times \frac{2 \times 14.01\ \text{lb N}}{60.06\ \text{lb}\ CH_4N_2O} = \boxed{0.133\ \text{lb N per dollar for}\ CH_4N_2O}$$

$(NH_4)_2SO_4$ has more N for the dollar.

2-91 The chemical formula for calcium carbonate is $CaCO_3$, and its molar mass is 100.09 g/mol. The mass of $CaCO_3$ needed to supply 1200 mg of Ca per day =

$$\underline{?}\ \text{g}\ CaCO_3\text{/day} = \frac{1200\ \text{mg Ca}}{1\ \text{day}} \times \frac{1\ \text{g Ca}}{1000\ \text{mg Ca}} \times \frac{100.09\ \text{g CaCO3}}{40.08\ \text{g Ca}} = 3.0\ \text{g}\ CaCO_3\text{/day}$$

2-93 Let x = atomic weight of metal M.

(a) $$\%\ \text{M} = \frac{\text{mass M}}{\text{mass M} + \text{mass O}} \times 100\% = \frac{2x}{2x + (3 \times \text{AW O})} \times 100\%$$

$$52.9\% = \frac{2x}{2x + (3 \times 16.00)} \times 100$$

$$\frac{52.9}{100} = \frac{2x}{2x + 48} \quad ; \quad 1.058\,x + 25.39 = 2x \quad ; \quad 0.942\,x = 25.39$$

$x = \boxed{27.0\ \text{amu}}$

(b) The metal is probably $\boxed{\text{aluminum}}$ (atomic weight 26.98) .

2-95 MW = 6.5×10^4 g/mol or 6.5×10^4 amu/molecule

$$\frac{\underline{?}\ \text{Fe atoms}}{\text{molecule}} = \frac{6.5 \times 10^4\ \text{amu hemoglobin}}{1\ \text{molecule}} \times \frac{0.35\ \text{amu Fe}}{100\ \text{amu hemoglobin}} \times \frac{1\ \text{Fe atom}}{55.85\ \text{amu Fe}} = 4.1$$

There are $\boxed{\text{4 iron atoms per hemoglobin molecule}}$.

2-97 FW $Ca_{10}(PO_4)_6(OH)_2$ = 1004.64 amu

(a) $$\%\ \text{Ca} = \frac{10 \times 40.08\ \text{amu Ca}}{1004.64\ \text{amu}} \times 100\% = \boxed{39.89\%\ \text{Ca}}$$

(b) $$\%\ \text{P} = \frac{6 \times 30.97\ \text{amu P}}{1004.64\ \text{amu}} \times 100\% = \boxed{18.50\%\ \text{P}}$$

2-99 For the cations given, the group number is the same as the charge. Rubidium would likely form a 1+ ion since it is in group 1. The formula for the cation formed from the barium atom would be: Ba^{2+}. The formula for the anion formed from the nitrogen atom would be: N^{3-}.

2-101 The new and old values for Avogadro's number are the same up to 7 significant digits; both are equal to 6.022141×10^{23}, but differ in the next digit. The uncertainty only has 2 significant digits (1.5 x

10^{17}). If the uncertainty were subtracted from 6.0221415 x 10^{23}, the result would be 6.0221414 x 10^{23}, so with the uncertainty, the two numbers are the same to 7 significant digits (6.0221415 x 10^{23} and 602,214,141,070,409,084,099,072).

2-103 All have the same empirical formula, CH_2O, which has a formula weight (FW) of 30.0 amu.

	Molecular Formula	**Molecular Weight (amu)**	**Ratio With Empirical FW**
Acetic Acid	$C_2H_4O_2$	60.0 amu	2
Erythrulose	$C_4H_8O_4$	120.0 amu	4
Formaldehyde	CH_2O	30.0 amu	1
Latic Acid	$C_3H_6O_3$	90.0 amu	3
Ribose	$C_5H_{10}O_5$	150.0 amu	5

2-105 There is insufficient information since the oxygen used in combustion comes from the air in addition to the oxygen in the sample.

2-107 $$\% \text{ Ag in } Ag_2O = \frac{2 \text{ x } 107.87 \text{ g } Ag}{231.74 \text{ g } Ag_2O} \text{ x } 100\% = 93.10\% \text{ Ag}$$

$$\% \text{ Ag in } Ag_2S = \frac{2 \text{ x } 107.87 \text{ g Ag}}{247.8 \text{ g } Ag_2S} \text{ x } 100\% = 87.06\% \text{ Ag}$$

Recommend that, if the ores are the same price and if they contain the same mass percent of the silver compounds, the silver oxide be used. However, in an actual situation, the price and concentration of the desired compound would probably be the determining factors. Pure Ag_2O and Ag_2S both contain a very high percentage of silver.

2-109 $$1 \text{ picomole x } \frac{1 \text{ x } 10^{-12} \text{ mole}}{1 \text{ picomole}} \text{ x } \frac{6.022 \text{ x } 10^{23} \text{ pennies}}{1 \text{ mole}} \text{ x } \frac{\frac{1}{16} \text{ in}}{\text{penny}} \text{ x } \frac{1 \text{ ft}}{12 \text{ in}} \text{ x } \frac{1 \text{ mile}}{5280 \text{ ft}}$$

= 5.9 x 10^5 miles which is greater than 222,000 miles **Yes , it will reach the moon .**

2-111 $$\underline{?} \text{ MW or g/mol of } B_{12} = \frac{100 \text{ g } B_{12}}{4.35 \text{ g Co}} \text{ x } \frac{58.93 \text{ g Co}}{1 \text{ mol Co}} \text{ x } \frac{1 \text{mol Co}}{1 \text{ mol } B_{12}} = \boxed{1.35 \text{ x } 10^3 \text{ g/mol } B_{12}}$$

2-113 % O = 100 % total – 92.83% Pb = 7.17% O

Element	Rel. Mass Element	Rel. No. of Atoms	Divide by Smallest
Pb	92.83	$\frac{92.83}{207.2} = 0.4480$	$\frac{0.4480}{0.448} = 1.00$
O	7.17	$\frac{7.17}{16.00} = 0.448$	$\frac{0.448}{0.448} = 1.00$
	Total 100.00		

The simplest formula is $\boxed{PbO}$

2-115 0.050 mL H_2O = 0.050 cm^3 H_2O, since 1 mL = 1cm^3

$$\underline{?}\text{ molecules of } H_2O = 0.050\ cm^3\ H_2O \times \frac{1\ mol\ H_2O}{18.02\ g\ H_2O} \times \frac{6.022 \times 10^{23}\ molecules\ H_2O}{1\ mol\ H_2O}$$

$$= \boxed{1.7 \times 10^{21}\ molecules\ H_2O}$$