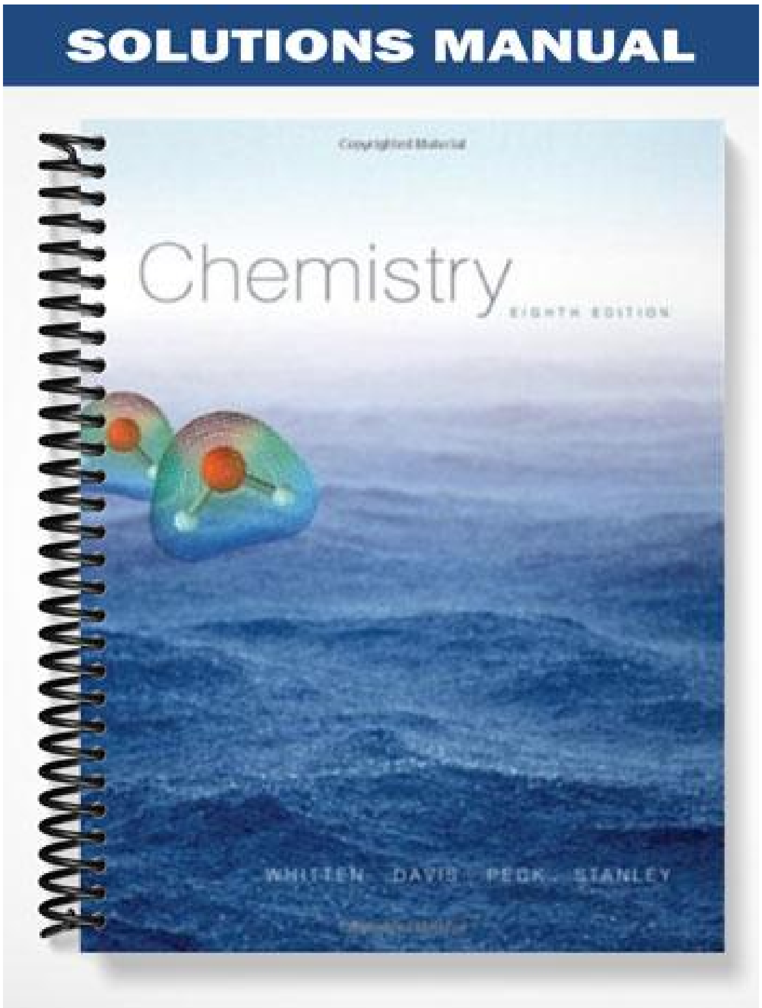

SOLUTIONS MANUAL
Copyrighted Material
Chemistry
EIGHTH EDITION
WHITTEN DAVIS PECK STANLEY

2 Chemical Formulas and Composition Stoichiometry

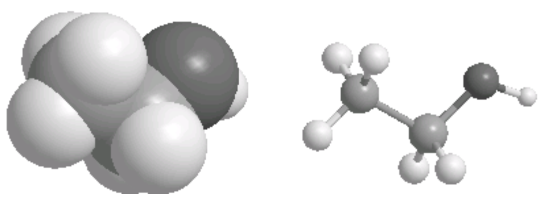
2-1 (a) Stoichiometry is the description of the quantitative relationships among elements in a compound and among substances as they undergo chemical change.

(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 number of protons in the nucleus, the charge of the nucleus, and the number of electrons surrounding the nucleus for each element are:

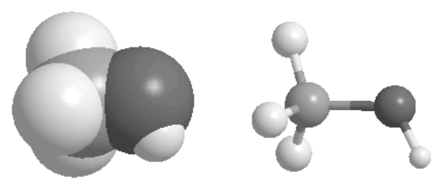
(a) helium: 2 protons, 2+, 2 electrons
(b) chlorine: 17 protons, 17+, 17 electrons
(c) calcium: 20 protons, 20+, 20 electrons
(d) zinc: 30 protons, 30+, 30 electrons
(e) boron: 5 protons, 5+, 5 electrons

2-5 Ethanol -CH_3CH_2OH



(space-filling; ball-and-stick)

Methanol-CH_3OH

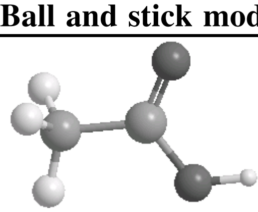
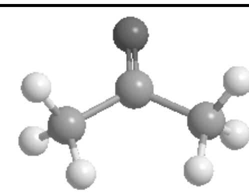
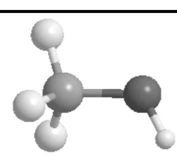
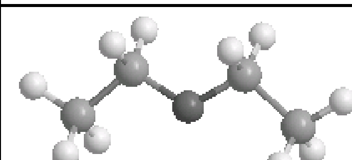


(space-filling; ball-and-stick)

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- $CH_3CH_2COCH_2$ CH_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) $Mg(NO_2)_2$, magnesium nitrite
(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 $\frac{?\ \text{amu}}{\text{atom}} \geq 12.011 \times 2 \geq 24.022$ amu/atom. The atomic weight of magnesium is 24.3050 amu/atom.

$$\boxed{\text{Magnesium, Mg, is the element with an atomic weight slightly over 24.022 amu.}}$$

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 ruthenium is almost twice that of an atom of vanadium (101.07/50.94).

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	=	**136.142**	**amu**

(b)

$$\begin{aligned} 3 \times C &= 3 \times 12.011 \text{ amu} = 36.033 \text{ amu} \\ 8 \times H &= 8 \times 1.0079 \text{ amu} = 8.0632 \text{ amu} \\ \hline FW &= \boxed{44.096 \text{ amu}} \end{aligned}$$

(c)

$$\begin{aligned} 6 \times C &= 6 \times 12.011 \text{ amu} = 72.066 \text{ amu} \\ 8 \times H &= 8 \times 1.0079 \text{ amu} = 8.0632 \text{ amu} \\ 1 \times S &= 1 \times 32.066 \text{ amu} = 32.066 \text{ amu} \\ 2 \times O &= 2 \times 15.9994 \text{ amu} = 31.9988 \text{ amu} \\ 2 \times N &= 2 \times 14.0067 \text{ amu} = 28.0134 \text{ amu} \\ \hline FW &= \boxed{172.207 \text{ amu}} \end{aligned}$$

(d)

$$\begin{aligned} 3 \times U &= 3 \times 238.0289 \text{ amu} = 714.0867 \text{ amu} \\ 14 \times O &= 14 \times 15.9994 \text{ amu} = 223.9916 \text{ amu} \\ 2 \times P &= 2 \times 30.9738 \text{ amu} = 61.9476 \text{ amu} \\ \hline FW &= \boxed{1000.0259 \text{ amu}} \end{aligned}$$

2-31 The ratio of masses present is $\frac{6.68 \text{ g Ca}}{6.33 \text{ g F}} = 1.055$ or $\frac{1.055 \text{ g Ca}}{1.0 \text{ g F}}$. Based on the formula CaF_2, this ratio represents $\frac{1 \text{ atom Ca}}{2 \text{ atoms F}}$. So the atomic mass ratio of Ca/F is $\frac{\text{AW Ca}}{\text{AW F}}$ or $\frac{1.055}{1.0/2} = \boxed{2.11}$

From a table of atomic weights, $\frac{\text{AW Ca}}{\text{AW F}} = \frac{40.08 \text{ amu}}{19.00 \text{ amu}} = \boxed{2.11}$

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

2-33 $\underline{?} \text{ g } H_2O_2 = 1.56 \text{ mol } H_2O_2 \times \frac{34.02 \text{ g } H_2O_2}{1 \text{ mol } H_2O_2} = \boxed{53.1 \text{ g } H_2O_2}$

2-35 (a) $\underline{?} \text{ Formula Units } K_2CrO_4 = 149.3 \text{ g } K_2CrO_4 \times \frac{1 \text{ mol } K_2CrO_4}{194.20 \text{ g } K_2CrO_4}$

$$\times \frac{6.022 \times 10^{23} \text{ For. Units } K_2CrO_4}{1 \text{ mol } K_2CrO_4} = \boxed{4.630 \times 10^{23} \text{ Form. Units } K_2CrO_4}$$

(b) $\underline{?} \text{ } K^+ \text{ ions} = 4.630 \times 10^{23} \text{ Formula Units } K_2CrO_4 \times \frac{2 \text{ } K^+ \text{ ions}}{1 \text{ For. unit } K_2CrO_4} =$

$$\boxed{9.260 \times 10^{23} \text{ } K^+ \text{ ions}}$$

(c) $\underline{?} \text{ } CrO_4^{2-} \text{ ions} = 4.630 \times 10^{23} \text{ Formula Units } K_2CrO_4 \times \frac{1 \text{ } CrO_4^{2-} \text{ ion}}{1 \text{ For. Unit } K_2CrO_4} =$

$$\boxed{4.630 \times 10^{23} \text{ } CrO_4^{2-} \text{ ions}}$$

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

$\underline{?} \text{ atoms} = 4.630 \times 10^{23} \text{ Formula units } K_2CrO_4 \times \frac{7 \text{ atoms}}{1 \text{ For. Unit } K_2CrO_4} = \boxed{3.241 \times 10^{24} \text{ atoms}}$

2-37 $\frac{6.688 \text{ g Ne}}{20.1797 \text{ g Ne per mole}} = \boxed{0.3314 \text{ mole Ne}}$

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	**S_8**	256.53 g
(f)	O	**O_2**	**31.9988 g**

2-43 $\underline{?} \text{ atoms Cu} = 1.0 \times 10^{-12} \text{ g Cu} \times \frac{1 \text{ mol Cu}}{63.546 \text{ g Cu}} \times \frac{6.022 \times 10^{23} \text{ atoms Cu}}{\text{mol Cu}} = \boxed{9.5 \times 10^{9} \text{ atoms Cu}}$

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

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

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

$$\% \text{ Fe} = \frac{3 \times 55.85 \text{ amu Fe}}{357.49 \text{ amu}} \times 100\% = \boxed{46.87\% \text{ Fe}}$$

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 ≈ 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 ≈ 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

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

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

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

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

(b) FW SiC = 40.097 amu

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

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

(c) FW $C_9H_8O_4$ = 180.17 amu

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

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

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

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

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

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

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

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

$$?\text{g C} = 1.100 \text{ g } CO_2 \text{ x } \frac{12.011 \text{ g C}}{44.010 \text{ g } CO_2} = \boxed{0.3002 \text{ g C}}$$

$$?\text{g H} = 0.1802 \text{ g } H_2O \text{ x } \frac{2(1.0079 \text{ g H})}{18.0152 \text{ g } H_2O} = \boxed{0.02016 \text{ g H}}$$

$$?\% \text{ C} = \frac{0.3002 \text{ g C}}{0.3204 \text{ g sample}} \text{ x } 100\% = \boxed{93.70\% \text{ C}}$$

$$?\% \text{ H} = \frac{0.02016 \text{ g H}}{0.3204 \text{ g sample}} \text{ x } 100\% = \boxed{6.29\% \text{ H}}$$

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

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

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

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

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	$\frac{0.163}{16.00} = 0.0102$	$\frac{0.0102}{0.00258} = 3.96 \approx 4$

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

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

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 Calculate the amount of Cl for a given amount of S in each compound:

First compound: $\frac{36.71 \text{ g Cl}}{8.30 \text{ g S}} = 4.42 \text{ g Cl/g S}$

Second compound: $\frac{39.11 \text{ g Cl}}{5.90 \text{ g S}} = 6.63 \text{ g Cl/g S}$

These are in the ratio 6.63 to 4.42 = 1.5 : 1 = 3 : 2. Thus the masses of Cl that combine with a fixed mass of S in the two compounds are in the ratio of small whole numbers, 3 : 2. Alternatively, the masses of S that combine with a fixed mass of Cl in the two compounds could be compared.

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

$\frac{63.55 \text{ amu Cu}}{183.54 \text{ amu } CuFeS_2}$ or $\frac{63.55 \text{ lb Cu}}{183.54 \text{ lb } CuFeS_2}$

$? \text{ lb Cu} = 4.63 \text{ lb } CuFeS_2 \times \frac{63.55 \text{ lb Cu}}{183.54 \text{ lb } CuFeS_2} = \boxed{1.60 \text{ lb Cu}}$

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

$$? \text{ g Cu} = 253 \text{ g } CuSO_4 \times \frac{63.55 \text{ g Cu}}{159.62 \text{ g } CuSO_4} = \boxed{101 \text{ g Cu}}$$

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

$$? \text{ g Cu} = 253 \text{ g } CuSO_4 \cdot 5H_2O \times \frac{63.55 \text{ g Cu}}{249.72 \text{ g } CuSO_4 \cdot 5H_2O} = \boxed{64.4 \text{ g Cu}}$$

2-79 $$? \text{ g } Cu_3(CO_3)_2(OH)_2 = 685 \text{ g Cu} \times \frac{344.69 \text{ g } Cu_3(CO_3)_2(OH)_2}{3 \times 63.55 \text{ g Cu}} = \boxed{1.24 \times 10^3 \text{ g } Cu_3(CO_3)_2(OH)_2}$$

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

$$? \text{ g } CaWO_4 = 625 \text{ g } FeWO_4 \times \frac{183.85 \text{ g W}}{303.70 \text{ g } FeWO_4} \times \frac{287.93 \text{ g } CaWO_4}{183.85 \text{ g W}} = \boxed{593 \text{ g } CaWO_4}$$

2-83 $$? \text{ g Pb} = 110.5 \text{ g ore} \times \frac{10.0 \text{ g PbS}}{100.0 \text{ g ore}} \times \frac{207.2 \text{ g Pb}}{239.26 \text{ g PbS}} = \boxed{9.57 \text{ g Pb/110.5 g ore}}$$

2-85 $$? \text{ g } Sr(NO_3)_2 = 276.7 \text{ g sample} \times \frac{88.2 \text{ g } Sr(NO_3)_2}{100.0 \text{ g sample}} = 244 \text{ g } Sr(NO_3)_2 \text{ present}$$

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

(a) $$? \text{ g Sr} = 244 \text{ g } Sr(NO_3)_2 \times \frac{87.62 \text{ g Sr}}{211.63 \text{ g } Sr(NO_3)_2} = \boxed{101 \text{ g Sr}}$$

(b) $$? \text{ g N} = 244 \text{ g } Sr(NO_3)_2 \times \frac{2 \times 14.0 \text{ g N}}{211.63 \text{ g } Sr(NO_3)_2} = \boxed{32.3 \text{ g N}}$$

2-87 (a) $$? \text{ g } CH_3COOH = 143.7 \text{ g vinegar} \times \frac{5.0 \text{ g } CH_3COOH}{100 \text{ g vinegar}} = \boxed{7.2 \text{ g } CH_3COOH}$$

(b) $$? \text{ lb } CH_3COOH = 143.7 \text{ lb vinegar} \times \frac{5.0 \text{ lb } CH_3COOH}{100 \text{ lb vinegar}} = \boxed{7.2 \text{ lb vinegar}}$$

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

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

$$\frac{? \text{ lb } NH_4NO_3}{\$} = \frac{1 \text{ lb } NH_4NO_3}{\$ \ 2.95} \times \frac{2 \times 14.01 \text{ lb N}}{80.05 \text{ lb } NH_4NO_3} = \boxed{0.119 \text{ lb N per dollar for } NH_4NO_3}$$

$$\frac{? \text{ lb } CH_4N_2O}{\$} = \frac{1 \text{ lb } CH_4N_2O}{\$ \ 3.65} \times \frac{2 \times 14.01 \text{ lb N}}{60.06 \text{ lb } CH_4N_2O} = \boxed{0.128 \text{ lb N per dollar for } CH_4N_2O}$$

CH_4N_2O 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) $$\%\text{ M} = \frac{\text{mass M}}{\text{mass M + mass O}} \times 100\% = \frac{2x}{2x + (3 \times \text{AW O})} \times 100\%$$

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

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

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

2-101 $$\%\text{ Ag in } Ag_2O = \frac{2 \times 107.87\text{ g Ag}}{231.74\text{ g } Ag_2O} \times 100\% = 93.10\%\text{ Ag}$$

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

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.

2-103 $$1\text{ picomole} \times \frac{1 \times 10^{-12}\text{ mole}}{1\text{ picomole}} \times \frac{6.022 \times 10^{23}\text{ pennies}}{1\text{ mole}} \times \frac{1/16\text{ in}}{\text{penny}} \times \frac{1\text{ ft}}{12\text{ in}} \times \frac{1\text{ mile}}{5280\text{ ft}}$$

= 5.9×10^5 miles which is greater than 222,000 miles $\boxed{\text{Yes , it will reach the moon .}}$

2-105 $\underline{?}$ MW or g/mol of B_{12} = $\frac{100 \text{ g } B_{12}}{4.35 \text{ g Co}} \times \frac{58.93 \text{ g Co}}{1 \text{ mol Co}} \times \frac{1 \text{mol Co}}{1 \text{ mol } B_{12}}$ = $\boxed{1.35 \times 10^3 \text{ g/mol } B_{12}}$

2-107 % 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 $\boxed{PbO}$

2-109 (a) $\underline{?}$ L/mol of H_2 = $\frac{1 \text{ cm}^3}{0.000089 \text{ g } H_2} \times \frac{1 \text{ mL}}{1 \text{ cm}^3} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{2.02 \text{ g } H_2}{1 \text{ mol } H_2}$ = $\boxed{22 \text{ L/mol } H_2O}$

(b)) $\underline{?}$ L/mol of H_2O = $\frac{1 \text{ cm}^3}{1.00 \text{ g } H_2O} \times \frac{1 \text{ mL}}{1 \text{ cm}^3} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{18.02 \text{ g } H_2O}{1 \text{ mol } H_2O}$ = $\boxed{0.0180 \text{ L/mol } H_2O}$

(c) $\underline{?}$ L/mol of Ag = $\frac{1 \text{ cm}^3}{10.5 \text{ g Ag}} \times \frac{1 \text{ mL}}{1 \text{ cm}^3} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{107.87 \text{ g Ag}}{1 \text{ mol Ag}}$ = $\boxed{0.0103 \text{ L/mol Ag}}$