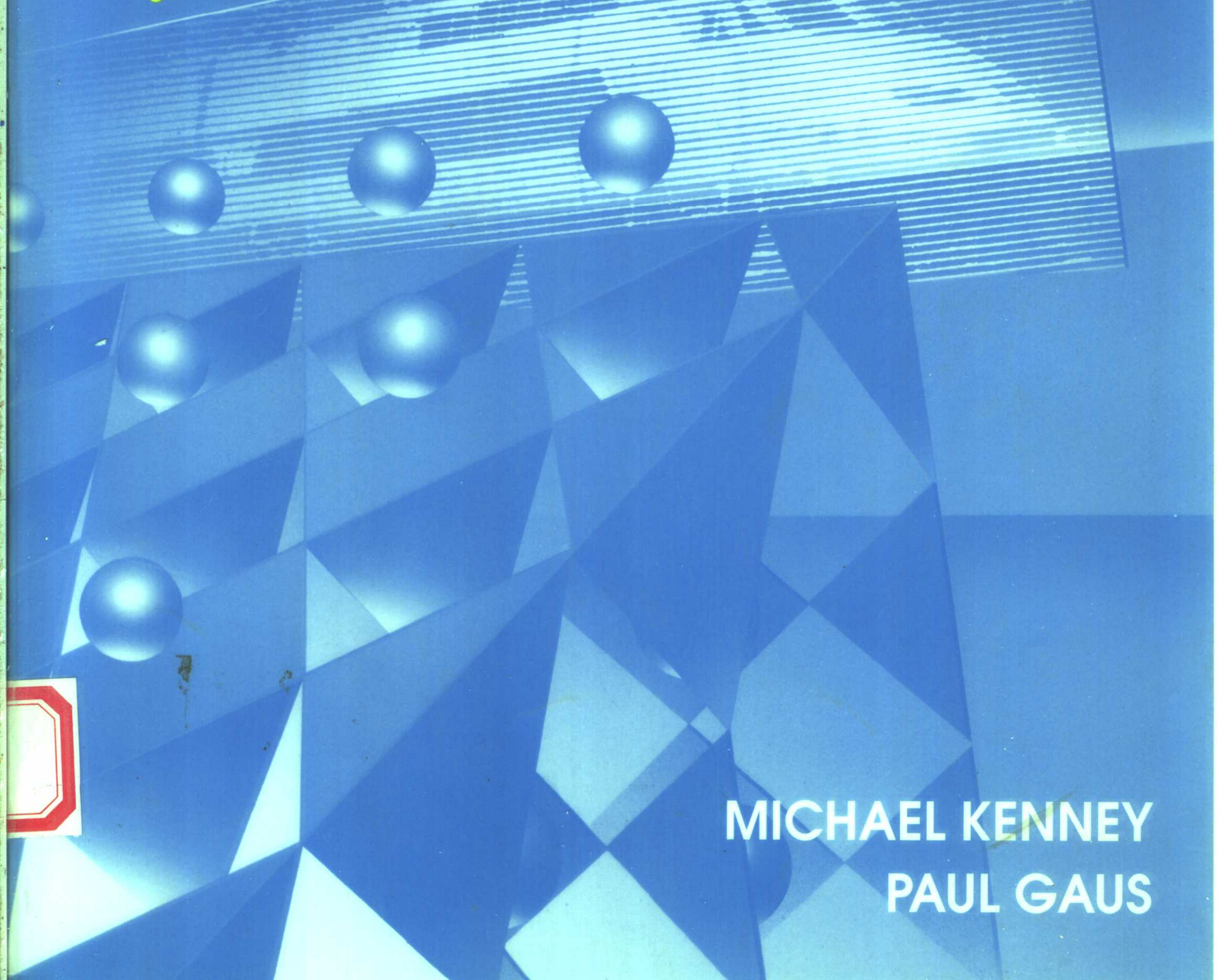
STUDENT SOLUTIONS MANUAL

BRADY AND HOLUM'S

CHEMISTRY

The Study of Matter and Its Changes

Second Edition



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Student Solutions Manual

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CHEMISTRY

The Study of Matter and Its Changes

Second Edition

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Preface

Congratulations! By investing in this Student Solutions Manual you have demonstrated a desire to go beyond the normal effort expended in order to understand the material presented in your class and the textbook. This solutions manual has been written to assist you as you explore the world around you from the perspective of a chemist.

Chemistry, for many people, is a strange and foreign language that will take time to comprehend and appreciate. It is filled with new vocabulary and ideas. It appears, to many, to be filled with abstract ideas and volumes of equations and symbols that are impossible to understand, let alone, commit to memory. Yet, an understanding of chemical phenomena and ideas will help you to understand the way the natural world works. A study of chemistry will provide you with a logical method of approaching a variety of problems. It will give you tools that may help you in a variety of tasks you will encounter throughout your lifetime.

In order to succeed in your studies it is imperative that you continually think about the material you are discussing in class, reading in the text or using to solve a problem. The information provided is intended to guide you to a specific point but it is up to you to follow the appropriate paths in order to find a reasonable solution.

This solutions manual provides completely worked out solutions to many of the exercises found at the end of each chapter of the text. I have tried to work each problem in a clear and logical fashion. Often, I have included commentary to help you to "see" the logic of a particular solution or to explain "why" a certain tact in solving a problem was used. I have tried to be consistent in the method used to solve problems and I have used dimensional analysis whenever appropriate.

The purpose of this manual is to help you to understand the concepts you are discussing and reading. It is intended to be used as a tool as you endeavor to understand the material. However, there are good and bad ways to use the information presented within these pages. When approaching a problem for the first time I recommend the following procedure:

- read the problem in order to determine the specific question being asked.
- restate the question in your own words.
- attempt to solve the problem using the tools you possess and learn in the course.
- check your solution to insure that it is reasonable, i.e., is it of the correct magnitude?, are the units correct?, is your solution the answer to the question that was asked?
- if you are unsure of the correctness of the answer or the units do not "work out" or you answered a different question than the one asked, seek assistance from a classmate, an instructor or this manual.
- always rework any problems that were difficult to understand.

Finally, I want to wish you good luck. I hope that you enjoy your chemistry course. I hope that you will find enjoyment as you embark upon a journey that will, hopefully, provide you with an understanding of the world around you.

Acknowledgments

I first want to thank my wife Cyndi. Her support and encouragement is the reason this project is completed. I also want to thank my editor Joan Kalkut. She has helped me immensely throughout this project. Bill Draper and Laura Swart-Hills provided much needed assistance when it was really needed. I especially want to thank the best proof readers I have ever had the pleasure to work with: Susan Holladay, Nicole Carlson and Kirsten Lowrey. They worked each and every problem in order to insure accuracy and completeness. They checked my work and caught my mistakes. They were generous in their suggestions of alternative wordings. They persevered even when deadlines approached and packages did not. Most importantly, they reminded me to always remember the students. Without their help, this manual would not be.

Michael J. Kenney
October 1995

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CHAPTER ONE
Review Exercises

1.16

(a)	0.01	10^{-2}
(b)	0.001	10^{-3}
(c)	1000	10^{3}
(d)	0.000001	10^{-6}
(e)	0.000000001	10^{-9}
(f)	0.000000000001	10^{-12}
(g)	1000000	10^{6}

1.18

(a)	0.01	(d)	0.1
(b)	1000	(e)	0.001
(c)	10^{12}	(f)	0.01

1.24 For these problems, use equations 1.1 and 1.2

(a) °F = 9/5(°C) + 32 = 9/5(60) + 32 = 140 °F, when rounded to the proper number (two) of significant figures.

(b) °F = 9/5(°C) + 32 = 9/5(20) + 32 = 68 °F

(c) °C = 5/9(°F – 32) = 5/9(45.5 – 32) = 7.5 °C

(d) °C = 5/9(°F – 32) = 5/9(59 – 32) = 15 °C

(e) K = °C + 273 = 40 + 273 = 313 K

(f) K = °C + 273 = –20 + 273 = 253 K

1.26 °F = 9/5(°C) + 32 = 9/5(37.46) + 32 = 99.43 °F

1.28 °C = K – 273 = 4 – 273 = –269 °C
°F = 9/5(°C) + 32 = 9/5(–269) + 32 = –452 °F

1.30 K = °C + 273 = –183 + 273 = 90 K

1.33

(a)	four	(b)	five	(c)	four
(d)	two	(e)	four	(f)	one

1.35 (a) 0.69 (b) 83.24 (c) 0.006
(d) 22.84 (e) 775.4 (Note: The subtraction gives 107.3 so 775.1 is also a possible answer.)

1.37 (a) 2.34×10^{3} (b) 3.10×10^{7} (c) 2.87×10^{-4}
(d) 4.50×10^{4} (e) 4.00×10^{-6} (f) 3.24×10^{5}

1.39 (a) 210,000 (b) 0.00000335 (c) 3800
(d) 0.0000000000046 (e) 0.00000346 (f) 850,000,000

1.41 (a) 2.0×10^{4}
(b) 8.0×10^{7}
(c) 1.0×10^{3}
(d) 2.4×10^{5}
(e) 2.0×10^{18}

1.46 (a) $$\# \text{ km} = (32.0 \text{ dm})\left(\frac{1 \text{ m}}{10 \text{ dm}}\right)\left(\frac{1 \text{ km}}{1000 \text{ m}}\right) = 3.20 \times 10^{-3} \text{ km}$$

(b) $$\# \mu\text{g} = (8.2 \text{ mg})\left(\frac{1 \text{ g}}{1000 \text{ mg}}\right)\left(\frac{1 \times 10^{6} \ \mu\text{g}}{1 \text{ g}}\right) = 8.2 \times 10^{3} \ \mu\text{g}$$

(c) $$\# \text{ kg} = (75.3 \text{ mg})\left(\frac{1 \text{ g}}{1000 \text{ mg}}\right)\left(\frac{1 \text{ kg}}{1000 \text{ g}}\right) = 7.53 \times 10^{-5} \text{ kg}$$

(d) $$\# \text{ L} = (137.5 \text{ mL})\left(\frac{1 \text{ L}}{1000 \text{ mL}}\right) = 0.1375 \text{ L}$$

(e) $$\# \text{ mL} = (0.025 \text{ L})\left(\frac{1000 \text{ mL}}{1 \text{ L}}\right) = 25 \text{ mL}$$

(f) $$\# \text{ dm} = (342 \text{ pm})\left(\frac{1 \text{ m}}{1 \times 10^{12} \text{ pm}}\right)\left(\frac{10 \text{ dm}}{1 \text{ m}}\right) = 3.42 \times 10^{-9} \text{ dm}$$

1.48 (a) $\# \text{ cm} = (36 \text{ in.})\left(\frac{2.54 \text{ cm}}{1 \text{ in.}}\right) = 91 \text{ cm}$

(b) $\# \text{ kg} = (5.0 \text{ lb})\left(\frac{1 \text{ kg}}{2.205 \text{ lb}}\right) = 2.3 \text{ kg}$

(c) $\# \text{ mL} = (3.0 \text{ qt})\left(\frac{946.4 \text{ mL}}{1 \text{ qt}}\right) = 2800 \text{ mL}$

(d) $\# \text{ mL} = (8 \text{ oz})\left(\frac{29.6 \text{ mL}}{1 \text{ oz}}\right) = 200 \text{ mL}$

(e) $\# \text{ km / hr} = (55 \text{ mi / hr})\left(\frac{1.609 \text{ km}}{1 \text{ mi}}\right) = 88 \text{ km / hr}$

(f) $\# \text{ km} = (50.0 \text{ mi})\left(\frac{1.609 \text{ km}}{1 \text{ mi}}\right) = 80.5 \text{ km}$

1.50 $\# \text{ mL} = (12 \text{ oz})\left(\frac{29.6 \text{ mL}}{1 \text{ oz}}\right) = 360 \text{ mL}$

1.52 $\# \text{ lb} = (1000 \text{ kg})\left(\frac{2.205 \text{ lb}}{1 \text{ kg}}\right) = 2205 \text{ lb}$

1.54 This individual is 74 in. tall, (6 ft)(12 in./ft) + 2 in.

$\# \text{ cm} = (74 \text{ in.})\left(\frac{2.54 \text{ cm}}{1 \text{ in.}}\right) = 190 \text{ cm}$

1.56 (a) $\# \text{ m}^2 = (6.2 \text{ yd}^2)\left(\frac{0.9144 \text{ m}}{1 \text{ yd}}\right)^2 = 5.2 \text{ m}^2$

(b) $\# \text{ mm}^2 = (4.8 \text{ in.}^2)\left(\frac{1 \text{ m}}{39.37 \text{ in.}}\right)^2\left(\frac{1000 \text{ mm}}{1 \text{ m}}\right)^2 = 3100 \text{ mm}^2$

(c) $\# \text{ L} = (3.7 \text{ ft}^3)\left(\frac{12 \text{ in.}}{1 \text{ ft}}\right)^3\left(\frac{2.54 \text{ cm}}{1 \text{ in.}}\right)^3\left(\frac{1 \text{ mL}}{1 \text{ cm}^3}\right)\left(\frac{1 \text{ L}}{1000 \text{ mL}}\right) = 1.0 \text{ X } 10^2 \text{ L}$

1.58 $$\frac{\#\ \text{km}}{\text{hr}} = \left(\frac{2235\ \text{ft}}{\text{s}}\right)\left(\frac{12\ \text{in.}}{1\ \text{ft}}\right)\left(\frac{2.54\ \text{cm}}{1\ \text{in.}}\right)\left(\frac{1\ \text{m}}{100\ \text{cm}}\right)\left(\frac{1\ \text{km}}{1000\ \text{m}}\right)\left(\frac{3600\ \text{s}}{1\ \text{hr}}\right) = 2452\ \frac{\text{km}}{\text{hr}}$$

1.60 $$\frac{\#\ \text{km}}{\text{hr}} = \left(\frac{65\ \text{miles}}{\text{hr}}\right)\left(\frac{1.609\ \text{km}}{1\ \text{mile}}\right) = 1.0 \text{ X } 10^2\ \frac{\text{km}}{\text{hr}}$$

1.69 The carbon dioxide and water vapor have less potential energy, because the reaction of oxygen with gasoline (combustion) releases potential energy when the products are formed. The excess potential energy of the gasoline and oxygen is transformed to heat.

1.75 $$\#\ \text{kg} = (18\ \text{gal})\left(\frac{3.786\ \text{L}}{1\ \text{gal}}\right)\left(\frac{1000\ \text{mL}}{1\ \text{L}}\right)\left(\frac{0.65\ \text{g}}{1\ \text{mL}}\right)\left(\frac{1\ \text{kg}}{1000\ \text{g}}\right) = 44\ \text{kg}$$

44 kg is equivalent to 97 lbs.

1.77 # mL = (25.0 g) ÷ (0.791 g/mL) = 31.6 mL

1.79 mass of silver = 62.00 g – 27.35 g = 34.65 g
volume of silver = 18.3 mL – 15.0 mL = 3.3 mL
density of silver = (mass of silver) ÷ (volume of silver)
= 34.65 g ÷ 3.3 mL = 11 g/mL

1.81 $$\text{sp. gr.} = \frac{d_{\text{substance}}}{d_{\text{water}}} = \frac{8.65\ ^{\text{lb}}/_{\text{gal}}}{8.34\ ^{\text{lb}}/_{\text{gal}}} = 1.04$$

1.83 The density of gold is 1.20 X 10^3 lb/ft^3 using equation 1.10.
lbs = (1 ft^3)(1.20 X 10^3 lb/ft^3) = 1.20 X 10^3 lb.

1.85 Since the density closely matches the known value, we conclude that this is an authentic sample of ethylene glycol.

1.89 (a) In order to determine the volume of the pycnometer, we need to determine the volume of water that fills it. We will do this using the mass ofg the water and its density.

mass of water = mass of filled pycnometer – mass of empty pycnometer
= 36.842 g – 27.314 g
= 9.528 g

$$\text{volume} = (9.528\ \text{g})\left(\frac{1\ \text{mL}}{0.99704\ \text{g}}\right) = 9.556\ \text{mL}$$

(b) We know the volume of chloroform from part (a). The mass of chloroform is determined in the same manner that we determined the mass of water;

mass of chloroform = mass of filled pycnometer − mass of empty pycnometer
= 41.428 g − 27.314 g
= 14.114 g

Density of chloroform = (14.114 g) ÷ (9.556 mL) = 1.477 g mL^{-1}

1.94 (a) $$\frac{\#\ g}{L} = \left(\frac{1.040\ g}{mL}\right)\left(\frac{1000\ mL}{L}\right) = 1040\ g/L = 1.040 \times 10^3\ g/L$$

(b) $$\frac{\#\ kg}{m^3} = \left(\frac{1.040\ g}{mL}\right)\left(\frac{1\ kg}{1000\ g}\right)\left(\frac{1\ mL}{1\ cm^3}\right)\left(\frac{100\ cm}{1\ m}\right)^3$$
$$= 1040\ kg/m^3 = 1.040 \times 10^3\ kg/m^3$$

1.96 First we need to recall the formula which describes the circumference of a circle: circumference = $2\pi r = 2\pi(6\text{ in.}) = 38 \times 10^2$ in. The circumference is the total distance a point on the edge travels in each revolution. To calculate speed:

$$\frac{\#\ miles}{hr} = \left(\frac{33\frac{1}{3}\ revolutions}{1\ minute}\right)\left(\frac{38\ in.}{1\ revolution}\right)\left(\frac{2.54\ cm}{1\ in.}\right)\left(\frac{1\ m}{100\ cm}\right)$$
$$\times \left(\frac{1\ km}{1000\ m}\right)\left(\frac{1\ mile}{1.609\ km}\right)\left(\frac{60\ min}{1\ hr}\right)$$
$$= 1.2\ miles/hr$$

1.98 (a) The average kinetic energy of the system must decrease since the system becomes "cool," i.e., the temperature decreases.

(b) The total heat of this system decreases as the system cools. Therefore, the total kinetic energy must decrease.

(c) Since energy must be conserved in this system (an insulated container), the potential energy must increase as a result of the decrease in kinetic energy.

1.100 (a) The only temperature at which any absolute scale overlaps any other absolute scale is zero.

(b) Since one fahrenheit degree unit is equivalent to one Rankine unit and one celcius degree unit is equivalent to one Kelvin unit, we can see that 9 Rankine degree units are equivalent to 5 Kelvin units (seeequation 1.1).

$$t_R = \left(\frac{9\ \mathrm{R}}{5\ \mathrm{K}}\right) t_K = \left(\frac{9\ \mathrm{R}}{5\ \mathrm{K}}\right)(373\ \mathrm{K}) = 671\ ^{\circ}\mathrm{R}$$

where we have used the value of 373 K as the boiling point of water on the Kelvin scale.

CHAPTER TWO
Review Exercises

2.8 (a) 2 K, 2 C, 4 O
(b) 2 H, 1 S, 3 O
(c) 12 C, 26 H
(d) 4 H, 2 C, 2 O
(e) 9 H, 2 N, 1 P, 4 O
(f) 4 C, 10 H, 1 O

2.10 (a) 1 Ni, 2 Cl, 8 O
(b) 1 Cu, 1 C, 3 O
(c) 2 K, 2 Cr, 7 O
(d) 2 C, 4 H, 2 O
(e) 1 N, 6 H, 1 P, 4 O
(f) 3 C, 8 H, 3 O

2.15 (a) 6 N, 3 O
(b) 14 C, 28 H, 14 O
(c) 4 Na, 4 H, 4 C, 12 O
(d) 4 N, 8 H, 2 C, 2 O
(e) 2 Cu, 2 S, 18 O, 20 H
(f) 10 K, 10 Cr, 35 O

2.16 (a) 6 (b) 3 (c) 27

2.24 An authentic sample of laughing gas must have a mass ratio of nitrogen/oxygen of 1.75 to 1.00. The only possibility in this list is item (c), which has the ratio of mass of nitrogen to mass of oxygen of 8.84/5.05 = 1.75.

2.26 (a) This ratio should be 4/2 = 2/1, as required by the formulas of the two compounds.
(b) Twice 0.597 g Cl, or 1.19 g Cl.

2.28 $12 \times 1.660566520 \text{ X } 10^{-24}$ g C = $1.992679824 \text{ X } 10^{-23}$ g C

2.30 Regardless of the definition, the ratio of the mass of hydrogen to that of oxygen would be the same. If C–12 were assigned a mass of 24 (twice its accepted value), then hydrogen would also have a mass twice its current value, or 2.0158 u.

2.32 $(0.7899 \times 23.9850 \text{ u}) + (0.1000 \times 24.9858 \text{ u}) + (0.1101 \times 25.9826 \text{ u}) = 24.31 \text{ u}$

2.41 (a) ${}^{131}_{53}I$ (b) ${}^{90}_{38}Sr$ (c) ${}^{137}_{55}Ce$ (d) ${}^{18}_{9}F$

2.42

	neutrons	protons	electrons
(a)	138	88	88
(b)	8	6	6
(c)	124	82	82
(d)	12	11	11

2.44

	neutrons	protons	electrons
(a)	46	35	36
(b)	32	26	23
(c)	34	29	27
(d)	50	37	36

2.51 Strontium and calcium are in the same Group of the periodic table, so they are expected to have similar chemical properties. Strontium should therefore form compounds that are similar to those of calcium, including the sorts of compounds found in bone.

2.53 Cadmium is in the same periodic table Group as zinc, but silver is not. Therefore, cadmium would be expected to have properties similar to those of zinc, whereas silver would not.

2.69 copper and gold

2.78 (a) Cl_2 (b) S_8 (c) P_4
(d) N_2 (e) O_2 (f) H_2

2.80 HAt

2.82 Bi_2O_3 and Bi_2O_5

2.84 $C_{10}H_{22}$

2.94 These ions are Ca^{2+} and Cl^{-}.

2.97 This requires a gain of three electrons. There are thus 7 protons and 10 electrons.

2.99 Rubidium, Rb, is in group 1 and has a +1 charge. When it combines with Cl, possessing a −1 charge, the formula would be RbCl. In the second compound, the metal atom should be written first; Na_2S.

2.106 (a) NaBr (b) KI (c) BaO (d) $MgBr_2$ (e) BaF_2

2.111 (a) KNO_3 (b) $Ca(C_2H_3O_2)_2$ (c) NH_4Cl
(d) $Fe_2(CO_3)_3$ (e) $Mg_3(PO_4)_2$

2.113 (a) PbO and PbO_2 (b) SnO and SnO_2 (c) MnO and Mn_2O_3
(d) FeO and Fe_2O_3 (e) Cu_2O and CuO

2.115 (a) $Ca(s) + Cl_2(g) \rightarrow CaCl_2(s)$
(b) $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$
(c) $4Al(s) + 3O_2(g) \rightarrow 2Al_2O_3(s)$
(d) $S(s) + 2Na(s) \rightarrow Na_2S(s)$ or $S_8(s) + 16Na(s) \rightarrow 8Na_2S(s)$

2.122 (a) calcium sulfide
(b) sodium fluoride
(c) aluminum bromide
(d) magnesium carbide
(e) sodium phosphide
(f) lithium nitride
(g) barium arsenide
(h) aluminum oxide

2.124 (a) silicon dioxide
(b) chlorine trifluoride
(c) xenon tetrafluoride
(d) disulfur dichloride
(e) tetraphosphorus decaoxide
(f) dinitrogen pentaoxide
(g) dichlorine heptaoxide
(h) arsenic pentachloride

2.126 (a) periodic acid
(b) iodic acid
(c) iodous acid
(d) hypoiodous acid
(e) hydroiodic acid

2.128 (a) sodium nitrite
(b) potassium phosphate
(c) potassium permanganate
(d) ammonium acetate
(e) barium sulfate
(f) ferric carbonate; iron(III) carbonate
(g) potassium thiocyanate
(h) sodium thiosulfate

2.130 (a) chromous chloride; chromium(II) chloride
(b) ammonium acetate
(c) potassium iodate
(d) chlorous acid
(e) calcium sulfite
(f) silver cyanide
(g) zinc(II) bromide
(h) hydrogen selenide
(i) hydroselenic acid
(j) vanadium(III) nitrate
(k) cobaltous acetate; cobalt(II) acetate
(l) auric sulfide; gold(III) sulfide
(m) aurous sulfide; gold(I) sulfide
(n) germanium tetrabromide
(o) potassium chromate
(p) ferrous hydroxide; iron(II) hydroxide
(q) diiodine tetraoxide
(r) tetraiodine nonaoxide
(s) tetraphosphorus triselenide

2.131 (a) Na_2HPO_4 (b) Li_2Se (c) NaH (d) $Cr(C_2H_3O_2)_3$ (e) $Ni(CN)_2$ (f) Fe_2O_3 (g) SnS_2 (h) SbF_5 (i) Al_2Cl_6 (j) As_4O_{10} (k) $Mg(OH)_2$ (l) $Cu(HSO_4)_2$ (m) NH_4SCN (n) $K_2S_2O_3$

2.133 (a) $Au(NO_3)_3$ (b) $CuSO_4$ (c) NH_4BrO_3 (d) $Ni(IO_3)_2$ (e) PbO_2 (f) Sb_2S_3 (g) $PtCl_2$ (h) CdS (i) $Ba(C_2H_3O_2)_2$ (j) Hg_2Cl_2 (k) $HgCl_2$ (l) $Sr_3(PO_4)_2$ (m) Ba_3As_2 (n) $Co(OH)_2$ (o) $Al_2(SO_3)_3$ (p) $(NH_4)_2Cr_2O_7$ (q) I_2O_5 (r) P_4S_7 (s) S_2F_{10}

2.135 (a) sodium bicarbonate or sodium hydrogen carbonate
(b) potassium dihydrogen phosphate
(c) ammonium hydrogen phosphate

2.137 (a) First calculate the number of moles of oxygen that are combined with X:

$$(1.14\text{ g oxygen})\left(\frac{1\text{ mole O}}{16.00\text{ g O}}\right) = 0.0713\text{ moles oxygen}$$

Then calculate the moles of X in the oxygen compound:

$$(0.0713\text{ moles O})\left(\frac{1\text{ mole X}}{2\text{ moles O}}\right) = 0.0356\text{ moles X}$$

Finally, calculate the molar mass of X:

$$\frac{1.00\text{ g X}}{0.0356\text{ moles X}} = 28.1\text{ g / mole X}$$

Note that X is Si, atomic number 14, and that its oxygen compound is SiO_2.

(b) The same number of moles of X are also combined with Y:

$$(0.0356\text{ moles X})\left(\frac{4\text{ moles Y}}{1\text{ moles X}}\right) = 0.142\text{ moles Y}$$

The atomic mass of Y is thus:

$$\frac{5.07\text{ g Y}}{0.142\text{ moles Y}} = 35.7\text{ g / mole Y}$$

Note that Y is Cl, atomic number 17, and that its compound with X is $SiCl_4$.

2.139 (a) $3H_2SO_4 + 2Al(OH)_3 \rightarrow Al_2(SO_4)_3 + 6H_2O$
(b) $H_2SO_4 + Ca(OH)_2 \rightarrow CaSO_4 + 2H_2O$

2.141 (a) hypochlorous acid and sodium hypochlorite; $NaOCl$
(b) iodous acid and sodium iodite; $NaIO_2$
(c) bromic acid and sodium bromate; $NaBrO_3$
(d) perchloric acid and sodium perchlorate; $NaClO_4$