Homework #1

Chapter 2

Atoms, Molecules, and Ions

19. 1 L (Cl_2) + 5 L (F_2) → 2 L (?)

For gases the volume is proportional to the number of participles. Since it is proportional, we can simplify the problem by assuming that 1 particle = 1 L. Therefore, 1 Cl_2 molecule and 5 F_2 molecules must come together to make 2 molecules of a product. The 2 molecules of the product together must contain 2 Cl atoms and 10 F atoms. Therefore, each molecule contains 1 Cl atoms and 5 F atoms, giving ClF_5.

Equation: $Cl_2(g) + 5F_2(g) \rightarrow 2ClF_5(g)$

21. 1 V (N_2) + 3 V (H_2) → 2 V (?)

For gases the volume is proportional to the number of participles. Since it is proportional, we can simplify the problem by assuming that 1 particle = 1 V. Therefore, 1 N_2 molecule and 3 H_2 molecules must come together to make 2 molecules of a product. The 2 molecules of the product together must contain 2 N atoms and 6 H atoms. Therefore, each molecule contains 1 N atoms and 3 H atoms, giving NH_3.

Equation: $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

28. Grapes are ~1 in diameter

Since the electrons are about 1 mile away the radius is ~1 mile and the diameter is 2 miles

Therefore, convert miles to inches

$$2\ mi\left(\frac{5{,}280\ ft}{1\ mi}\right)\left(\frac{12\ in}{1\ ft}\right) = 126{,}720\ in$$

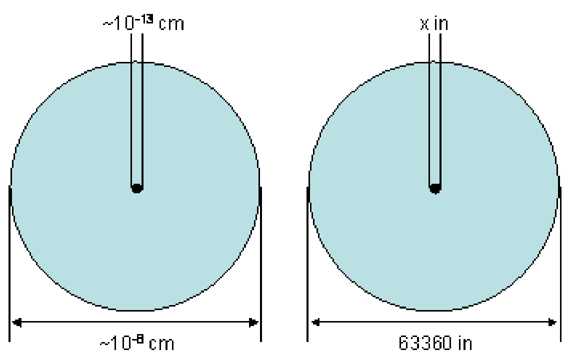

Figure 2.13 from book

The ratio of $\frac{nucleous\ size}{electron\ cloud\ size}$ is $\frac{10^{-13}\ cm}{10^{-8}\ cm} = 1 \times 10^{-5}$ for an atom

The ration for the $\frac{nucleous\ size}{electron\ cloud\ size}$ is $\frac{1\ in}{126{,}720\ in} = 8 \times 10^{-6}$ for the analogy.

Since the 2 ratio are similar the analogy is good.

32. a) *Molecule:* A neutrally charged group of atoms that are covalently bonded.

Ion: A charged species that can either contain a single atom or a group of atoms that are covalently bonded.

b) *Covalent bond:* Atoms that are held together by sharing electrons. Covalent bonds form between nonmetal atoms.

Ionic bond: Ions that are held together by the forces that attracts two oppositely charged species. Ionic bonds form between a metal cation and a non metal anion.

c) *Molecule:* A group of two or more non metal atoms held together by covalent bonds. The atoms in a molecule can be the same type example: H_2.
Compound: A substance containing two or more types of atoms that are either held together with covalent or ionic bonds.

d) Anion: An ion with a negative charge (due to an atom gaining electrons)
Cation: An ion with a positive charge (due to an atom losing electrons)

34. a)

Mg	metal
Ti	metal
Au	metal
Bi	metal
Si	nonmetal
Ge	metal
B	nonmetal
At	nonmetal
Rn	nonmetal
Eu	metal
Am	metal
Br	nonmetal

b) metalloids: B, Si, Ge, As, Sb, and Te (Po and At are sometimes recognized as metalloids)
Therefore Si, Ge, B, and At, would be reclassified

36. Carbon is a nonmetal. Silicon and germanium are called metalloids as they exhibit both metallic and nonmetallic properties. Tin and lead are metals. Therefore, the metallic characteristics of elements increases as you go down groups in the periodic table. As you go across a period, from left to right the metallic characteristics of the elements decrease.

37.

a) chlorine (Cl)	halogen
b) beryllium (Be)	alkaline earth metal
c) europium (Eu)	lanthanide metal
d) hafnium (Hf)	transition metal
e) helium (He)	noble gas
f) uranium (U)	actinide metal
g) caesium (Cs)	alkali metal

42. a) $^{58}_{27}Co$ b) $^{10}_{5}B$ c) $^{23}_{12}Mg$ d) $^{132}_{53}I$ e) $^{19}_{9}F$ f) $^{65}_{29}Cu$

43.

	Symbol	# of p	# of n	# of e$^-$
a	$^{24}_{12}Mg$	12	12	12
B	$^{23}_{12}Mg^{2+}$	12	12	10
C	$^{59}_{27}Co^{2+}$	27	32	25
D	$^{59}_{27}Co^{3+}$	27	32	24
E	$^{59}_{27}Co$	27	32	27
F	$^{79}_{34}Se$	34	45	34
G	$^{79}_{34}Se^{2-}$	34	45	36
H	$^{63}_{28}Ni$	28	35	28
I	$^{63}_{28}Ni^{2+}$	28	31	26

44.

Symbol	# of p	# on n	# of e$^-$	Net Charge
$^{238}_{92}U$	92	146	92	0
$^{40}_{20}Ca^{2+}$	20	20	18	2+
$^{51}_{23}V^{3+}$	23	28	20	3+
$^{89}_{39}Y$	39	50	39	0
$^{79}_{35}Br^{-}$	35	44	36	1-
$^{31}_{15}P^{3-}$	15	16	18	3-

45. Z = p + n = 63 + 88 = 151
A = p = 63

$$^{151}_{63}Eu^{3+}$$

Z = p + n = 50 + 68 = 118
A = p = 50

$$^{118}_{50}Sn^{2+}$$

47.

	Element	Gain/Lose	Ion
a.	Ra	Lose	Ra^{2+}
b.	In	Lose	In^{3+}
c.	P	Gain	P^{3-}
d.	Te	Gain	Te^{2-}
e.	Br	Gain	Br^{-}
f.	Rb	Lose	Rb^{+}

48.

	Atomic #	Element	Ion
a.	13	Al	Al^{3+}
b.	34	Se	Se^{2-}
c.	56	Ba	Ba^{2+}
d.	7	N	N^{3-}
e.	87	Fr	Fr^{+}
f.	35	Br	Br^{-}

53. a) sulfur difluoride
b) dinitrogen tetroxide (drop the final vowel of the prefix if the element starts with a vowel)
c) iodine trichloride
d) tetraphosphorus hexoxide (drop the final vowel of the prefix if the element starts with a vowel)

54. a) sodium perchlorate b) magnesium phosphate
c) aluminum sulfate d) sulfur difluoride
e) sulfur hexafluoride f) sodium hydrogen phosphate
g) sodium dihydrogen phosphate h) lithium nitride
i) sodium hydroxide j) magnesium hydroxide
k) aluminum hydroxide l) silver chromate*
* Even though silver is a transition metal it can only have one oxidation state, therefore, you do not include roman numerals.

55. a) copper(I) iodide b) copper(II) iodide
c) cobalt(II) iodide d) sodium carbonate
e) sodium hydrogen carbonate f) tetrasulfur tetranitride
g) selenium tetrabromide h) sodium hypochlorite
i) barium chromate j) ammonium nitrate

56. a) acetic acid b) ammonium nitrite
c) cobalt(III) sulfide d) iodine monochloride
e) lead(II) phosphate f) potassium chlorate
g) sulfuric acid h) strontium nitride
i) aluminum sulfite j) tin(IV) oxide*
k) sodium chromate l) hypochlorous acid
*While tin can have oxidation states of 4+ and 2+ in this case the oxidation state would be 4+ therefore, the compound is not tin(II) perodixe but tin(IV) oxide. I will not give you anything this tricky on tests.

57. a) SO_2 b) SO_3 c) Na_2SO_3 d) $KHSO_3$ e) Li_3N f) $Cr_2(CO_3)_3$
g) $Cr(C_2H_3O_2)_2$ h) SnF_4 i) NH_4HSO_4 j) $(NH_4)_2HPO_4$ k) $KClO_4$ l) NaH
m) HBrO n) HBr

58. a) Na_2O b) Na_2O_2 c) KCN d) $Cu(NO_3)_2$ e) $SiCl_4$ f) PbO
g) PbO_2 h) CuCl i) GaAs j) CdSe k) ZnS
l) Hg_2Cl_2 (mercury(I) is a poly atomic ion Hg_2^{2+}) m) HNO_2 n) P_2O_5

59. a) lead(II) acetate b) copper(II) sulfate c) calcium oxide
d) magnesium sulfate e) magnesium hydroxide f) calcium sulfate
g) dinitrogen monoxide

60. a) $FeCl_3$ iron chloride

should be iron(III) chloride

Iron forms more than one type of ion, therefore, roman numerals need to be used to denote which ion.

b) NO_2 nitrogen(IV) oxide

should be nitrogen dioxide

Both nitrogen and oxygen are nonmetals, therefore, the covalent naming system (Greek roots) should be used.

c) CaO calcium(II) monoxide

should be calcium oxide

Calcium only forms one ion, therefore, you do not need to include a roman numeral.

CaO is an ionic compound (metal + nonmetal), therefore, you do not use Greek roots.

d) Al_2S_3 dialuminum trisulfide

should be aluminum sulfide

Al_2S_3 is an ionic compound (metal + nonmetal), therefore, you do not use Greek roots.

e) $Mg(C_2H_3O_2)_2$ manganese diacetate

should be magnesium acetate

Mg is magnesium not manganese (Mn).

Mg is a metal and acetate is a polyatomic ion, therefore, the compound must be named like an ionic compound not a covalent compound.

f) $FePO_4$ iron(II) phosphide

should be iron(III) phosphate

PO_4^{3-} is phosphate and P^{3-} is phosphide.

The charge on phosphate is 3-, therefore, the charge on the Fe must be 3+.

g) P_2S_5 phosphorous sulfide

should be diphosphorus pentasulfide

Both phosphorous and sulfur are non metals, therefore, the covalent naming system (Greek roots) should be used.

h) Na_2O_2, sodium oxide

should be sodium peroxide

O_2^{2-} is a polyatomic ion, peroxide.

i) HNO_3, nitrate acid

should be nitric acid

If a polyatomic ion, in an acid, ends with –ate the root of the polyatomic ion is joined with –ic acid.

j) H_2S, sulfuric acid

should be hydrosulfuric acid

Anytime there is only H and 1 other type of atom hydro- is added to the beginning of the acids name and –ic is add to the root of the atom.

65. The equation that is being represented is $2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$

Picture 1 depicts sodium atoms that are in the solid phase.

Picture 2 depicts Cl_2 gas molecules. The Cl atoms are held together with covalent bond in the Cl_2 molecule.

Picture 3 depicts solid NaCl. NaCl is an ionic compound.

71. If X forms the compound XBr_2 the ion that forms must be X^{2+}. Since the ion has 86 electrons the atom must have 88 protons making it radium, Ra.

A = #p + # n

#n = A-#p=230 - 88 = 142

78.
- a) Ca_3N_2 calcium nitride
- b) K_2O potassium oxide
- c) RbF rubidium fluoride
- d) MgS magnesium sulfide
- e) BaI_2 barium iodide
- f) Al_2Se_3 aluminum selenide
- g) Cs_3P cesium phosphide
- h) $InBr_3$ indium bromide

90.

a) The easy way to solve this problem is to assume that experiment one has a chemical formula of XY and experiment 2 has a chemical formula of YZ (Another equally valid assumption would be that experiment three has a formula of XY and experiment 2 has a formula of YZ.)

b) Below is that data that was given in the problem:

Compound	Amount of X (g)	Amount of Y (g)	Amount of Z (g)
1	0.4	4.2	
2		1.4	1.0
3	2.0	7.0	

To determine the relative weights of X, Y, and Z, scale experiment one to have 1 gram of Y.Y was set to 1 because all of the compounds have Y in them

Compound	Amount of X (g)	Amount of Y (g)	Amount of Z (g)
1 scaled	$\frac{0.4}{4.2} = 0.095$	$\frac{0.4}{4.2} = 1.0$	

Therefore, for every 1 gram of Y there are 0.095 grams of X. To determine the relative weight of Z, scale experiment 2 to have 1.0 g of Y.

Compound	Amount of X (g)	Amount of Y (g)	Amount of Z (g)
2 scaled		$\frac{1.4}{1.4} = 1.0$	$\frac{1.0}{1.4} = 0.71$

Therefore, for every 1 gram of Y there is 0.095 g of X and 0.71 g of Z. Or the mass of X is 0.095 times that of Y and the mass of Z is 0.71 times that of Y.

X:Y:Z = 0.095 g:1.0g:0.71 g (there are multiple correct answer for this part but if you made the same assumptions (compound 1 XY and compound 2 YZ) then your answer should be proportional to this answer.

c) In part a we assumed that the formula of experiment 1 was XY and experiment 2 is YZ. To get the formula of experiment 3 apply to law of multiple proportions. In order to do this experiment three needs to be scaled to have 1.0 grams of Y.

Compound	Amount of X (g)	Amount of Y (g)	Amount of Z (g)
1	0.095	1.0	
3 scaled	$\frac{2.0}{7.0} = 0.29$	$\frac{7.0}{7.0} = 1.0$	

2.9 is 3 times larger than 0.095 therefore the chemical formula for experiment 3 would be X_3Y.

d) The mass % of each of the types of atoms is constant regardless of sample size. Therefore, since experiment one (X=0.095 g and Y=1.0 g) was assumed to have the formula XY the mass percent can be determined from this experiment.

$$mass\ \%\ X = \frac{m_X}{m_{tot}} 100\% = \frac{0.095\ g}{0.095\ g + 1.0\ g} 100\% = 8.7\%$$

$$mass\ \%\ Y = \frac{m_Y}{m_{tot}} 100\% = \frac{1.0\ g}{0.095\ g + 1.0\ g} 100\% = 91.3\%$$

Determine the mass of X in the 21 g sample

$$m_X = (21g)(0.087) = 1.8\ g$$

Determine the mass of Y in the 21 g sample

$$m_Y = (21g)(0.913) = 19.2\ g$$

Note: If you had assumed that experiment three was XY then you should have found that there is 4.7 g of X and 16.3 g of Y.

91. The following data was collected:

Experiment	Amount of R (g)	Amount of Q (g)
1	14.0	3.0
2	7.0	4.5

In order to compare experiment 1 and 2 you need to scale experiment 2 such that 14.0 grams of R was use. This would give the following

Experiment	Amount of R (g)	Amount of Q (g)
2(scaled)	7.0x2=14.0	4.5x2=9.0

To see if this is consistent with the law of multiple proportions you need to compare the ratio of the two amounts of Q. If these come out to a whole number then it is consistent.

$$\frac{larger\ number}{smaller\ number} = \frac{9.0}{3.0} = 3.0$$

Therefore, this is consistent with the law of multiple proportions.

If experiment 2 had the formula RQ then experiment one would have the formula $RQ_{1/3}$. Chemical formulas do not have fractions in them, to get rid of the fraction assume there are 3 R atoms. This results in the chemical formula R_3Q.

94. For gases the volume is proportional to the number of participles. Since it is proportional, we can simplify the problem by assuming that 1 particle = 1 V.

For reaction 1:

$$1\ V\ (X_?) + 2\ V\ (Y_?) \rightarrow 2\ V\ (X_?Y_?)$$

The only way to form 2 particles of product (compound 1) is to have X be a diatomic (X_2)

For reaction 2:

$$2\ V\ (X_2) + 1\ V\ (Y_?) \rightarrow 2\ V\ (X_?Y_?)$$

The only way to form 2 particles of product (compound 2) is to have Y be a diatomic (Y_2)

This suggests that compound 1 is XY_2 and compound 2 is X_2Y.

The mass percent data can be used to check the formulas.

Compound 1 (XY_2) is 30.45% X and 69.57% Y. If you have 100 g then 30.45 g are X and 69.57 g are Y. Therefore, the relative mass ratio of X:Y is 30.45:34.79.

If this is the case then compound 2 (X_2Y) would have the following mass percent:

$$mass\ \%\ x = \frac{2(30.45)}{2(30.45)+34.79} 100\% = 63.64\%$$

$$mass\ \%\ y = \frac{34.79}{2(30.45)+34.79} 100\% = 36.36\%$$

This is consistent with the experimentally found data therefore:

Compound 1: XY_2 and Compound 2: X_2Y