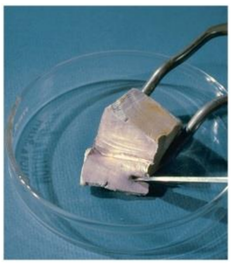
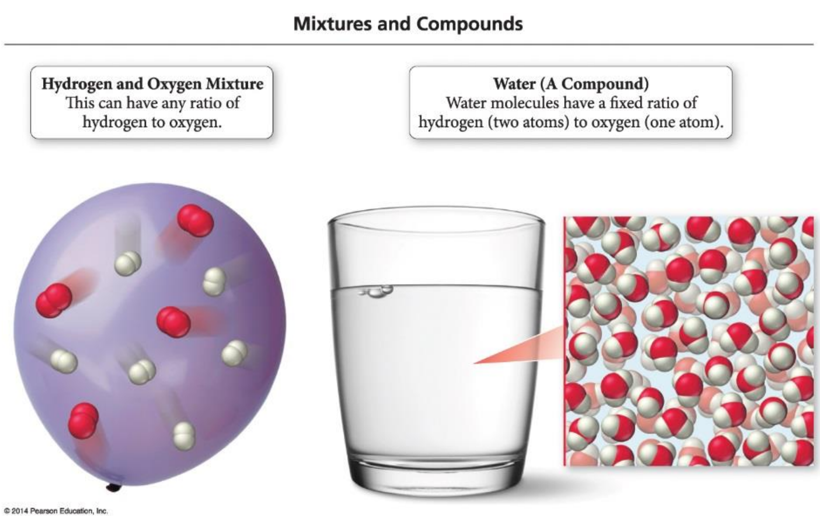
COMPOUNDS

- Compounds are pure substances that contain 2 or more elements combined in a definite proportion by mass.

- Compounds have unique properties compared to their component elements. For example, although both Na and Cl are extremely reactive and poisonous substances, compound from combination of them, NaCl, is a relatively harmless flavor enhancer.

 +  → 

- Compounds are formed from elements by combining in a definite, fixed composition.



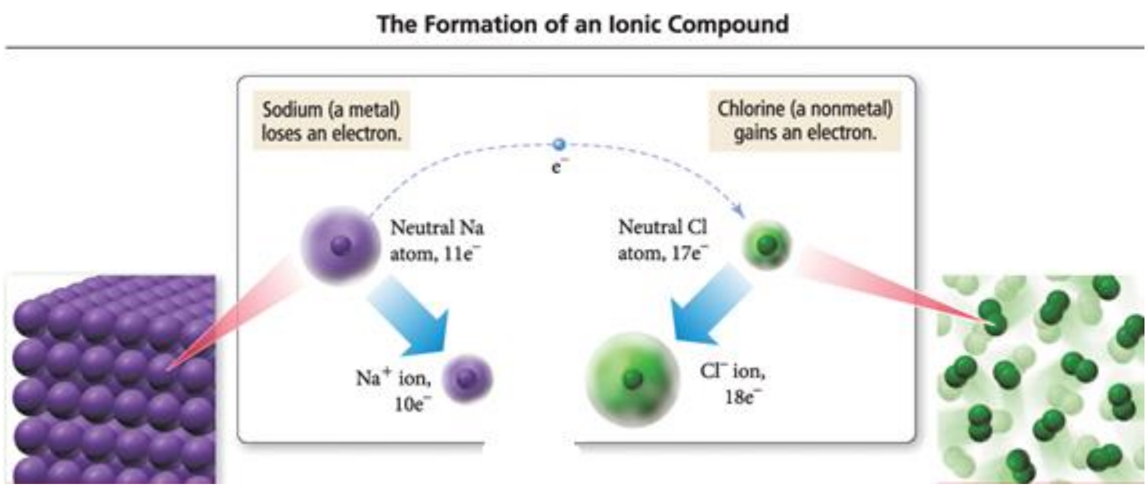
- The ratio of hydrogen to oxygen is ***variable in a mixture***, while it is ***fixed in a compound*** such as water.

CHEMICAL BONDS

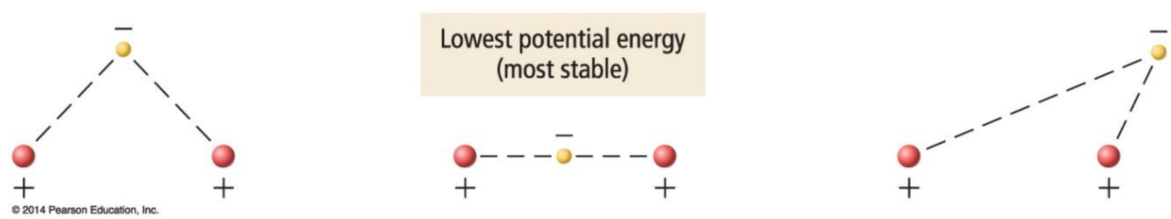
- Compounds are composed of atoms held together by ***chemical bonds***. Chemical bonds result from the attraction between the charged particles that compose the atoms.

- Chemical bonds can be classified into one of two types: ***ionic*** and ***covalent***.

- ***Ionic bonds***, which occur between metals and non-metals, involves ***transfer of electrons***. In these compounds, the metal loses electrons to form cation, and the non-metal gains electrons to form anions. The oppositely charged ions attract one another by electrostatic forces to form an ionic bond. Compounds formed through formation of these types of bonds are called ***ionic compounds.***



- ***Covalent bonds***, which occur between two non-metals, involves sharing of electrons. The shared electrons have lower potential energy than they would in the isolated atoms because they interact with the nuclei of both atoms. The resulting bond formed is a covalent bond, and the covalently bonded atoms compose a molecule. Compounds formed through formation of these types of bonds are called ***molecular compounds***.



TYPES OF FORMULAS

- A ***chemical formula*** is an ***abbreviation*** for a compound.
- It shows the ***symbols*** and the ***ratio*** of the ***atoms*** of the elements present in the compound.

$$Ca(NO_3)_2$$

Indicates the element calcium (one atom)

Indicates the nitrate group composed of one nitrogen atom and three oxygen atoms

Indicates two nitrate (NO_3) groups

- Chemical formulas can be categorized into 3 types:

  1. Molecular formula
  2. Empirical formula
  3. Structural formula

- A ***molecular formula*** is the ***actual number*** of atoms of each element in a compound. For example, the molecular formula for hydrogen peroxide is H_2O_2, because a molecule of hydrogen peroxide actually contains 2 hydrogen and 2 oxygen atoms.
- An ***empirical formula*** is the ***simplest whole-number ratio*** of atoms of each element in a compound. For example, hydrogen peroxide would have an empirical formula of HO, since this is the smallest ratio of its atoms.
- A structural formula uses lines to represent chemical bonds and shows how atoms in a molecule are connected to each other. For example, hydrogen peroxide would have the structural formula shown below:

H–O–O–H

Examples:

1. Give the empirical formula that corresponds to each molecular formula shown below:

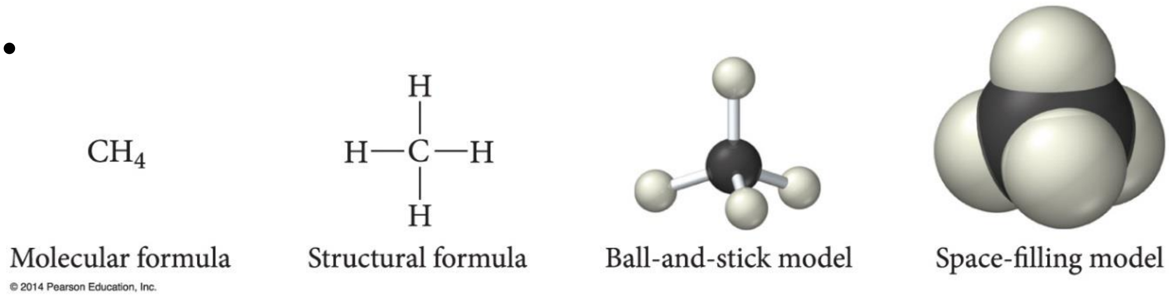
   a) C_4H_8

   b) CCl_4

   c) B_2H_6

MOLECULAR MODELS

- Molecular models are often used to represent 3-dimensional representations of compounds in a more accurate and complete way. Shown below, are various ways the compound methane can be represented.
-



ATOMIC VIEW OF ELEMENTS & COMPOUNDS

- Recall that all pure substances can be classified as element or compound. We can further subcategorize elements and compounds according to the basic units that compose them.

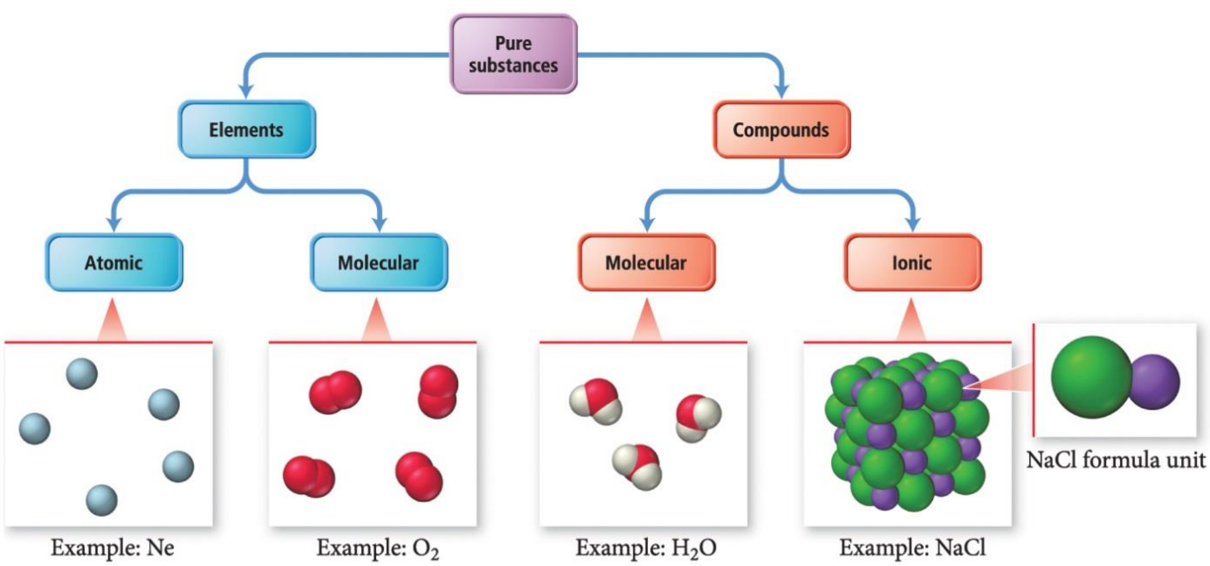
- Elements may be either ***atomic or molecular***, while compounds can be either ***molecular or ionic***. The smallest particles of matter can be therefore ***atoms, molecules or ions.***

- ***Atomic elements*** are those that exist as single atoms. Most elements fall into this category. ***Molecular elements*** are those that exist naturally as diatomic molecules. Among these are hydrogen, nitrogen, oxygen as well as the four halogens: F_2, Cl_2, Br_2 and I_2.

- ***Molecular compounds*** are compounds of 2 non-metals. Two examples are water (H_2O) and dry ice (CO_2).

- ***Ionic compounds*** are composed of one or more cations paired with one or more anions. In most cases, the cations are metals and the anions are non-metals. The basic unit of ionic compounds is not a molecule, but a formula unit. Examples are sodium chloride, NaCl, which is composed of Na^+ and Cl^- ions.

Classification of Elements and Compounds



Examples:

1. Classify each substance as atomic element, molecular element, molecular compound or ionic compound:

    a) xenon

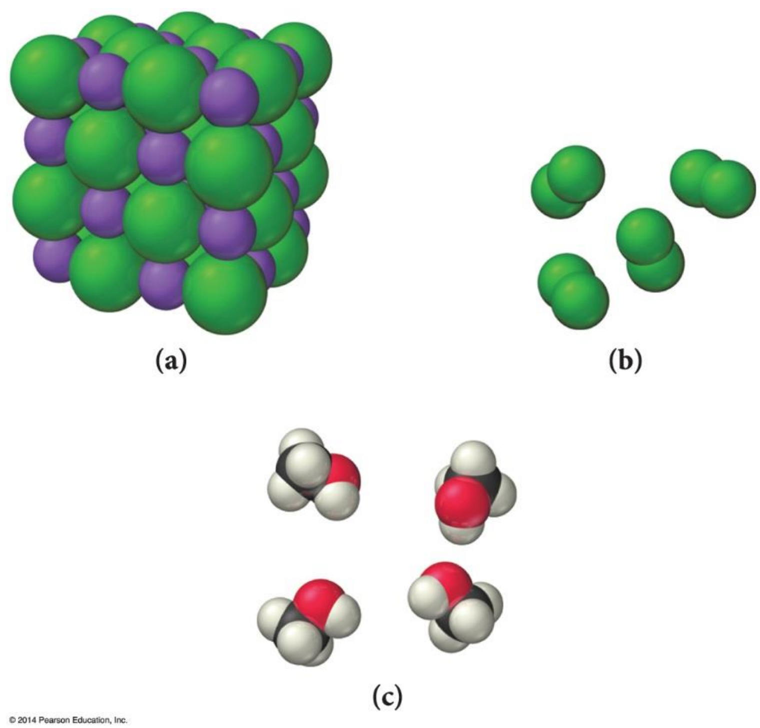
    b) $NiCl_2$

    c) bromine

    d) NO_2

    e) $NaNO_3$

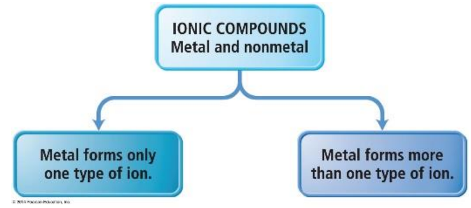
2. Based on molecular views, classify each substance as atomic element, molecular element, molecular compound or ionic compound:



WRITING IONIC FORMULAS

- When writing ionic formula, knowing the charge of the ions are important since the net charge on the compound must be zero.

- Some elements produce only one ion (***Type I***) while others produce two or more ions (***Type II***).



- Differentiating between type I and II ions is important, since the naming system is different for each. The tables below show the common ions of each type.

TABLE 3.2 Metals Whose Charge Is Invariant from One Compound to Another

Metal	Ion	Name	Group Number
Li	Li^+	Lithium	1A
Na	Na^+	Sodium	1A
K	K^+	Potassium	1A
Rb	Rb^+	Rubidium	1A
Cs	Cs^+	Cesium	1A
Be	Be^{2+}	Beryllium	2A
Mg	Mg^{2+}	Magnesium	2A
Ca	Ca^{2+}	Calcium	2A
Sr	Sr^{2+}	Strontium	2A
Ba	Ba^{2+}	Barium	2A
Al	Al^{3+}	Aluminum	3A
Zn	Zn^{2+}	Zinc	*
Sc	Sc^{3+}	Scandium	*
Ag	Ag^+	Silver	*

*The charge of these metals cannot be inferred from their group number.

TABLE 3.4 Some Metals That Form Cations with Different Charges

Metal	Ion	Name
Chromium	Cr^{2+}	Chromium(II)
	Cr^{3+}	Chromium(III)
Iron	Fe^{2+}	Iron(II)
	Fe^{3+}	Iron(III)
Cobalt	Co^{2+}	Cobalt(II)
	Co^{3+}	Cobalt(III)
Copper	Cu^{+}	Copper(I)
	Cu^{2+}	Copper(II)
Tin	Sn^{2+}	Tin(II)
	Sn^{4+}	Tin(IV)
Mercury	Hg_2^{2+}	Mercury(I)
	Hg^{2+}	Mercury(II)
Lead	Pb^{2+}	Lead(II)
	Pb^{4+}	Lead(IV)

- Note that most main-group elements are type I (except Sn and Pb), and most transition elements are type II (except Ag, Sc and Zn).

WRITING FORMULAS FOR IONIC COMPOUNDS

Binary Ionic Compounds:

- ***Binary*** compounds contain only ***two elements***.
- In these compounds, ***charges of the cations must equal the charges of the anions*** since the ***net charge is zero***.
- ***Subscripts*** are used to ***balance*** the charges between cations and anions.

Elements	Ions	Formula
potassium and sulfur	K^+, S^{-2}	K_2S
aluminum and oxygen		
lead (IV) and oxygen		

Examples:

1. Write formulas for ionic compounds formed from the following elements:

a) calcium & chlorine: _____________

b) sodium & sulfur: _______________

c) aluminum & nitrogen _______________

d) copper (I) & phosphorus ______________

e) iron (III) & sulfur _________________

NAMING IONIC COMPOUNDS

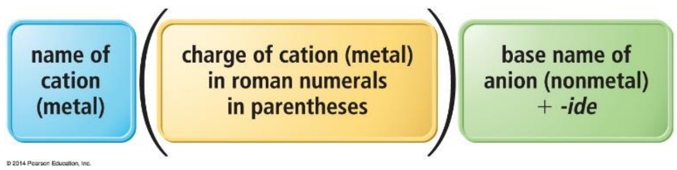
Type I:

- These compounds are named by naming the cation (same as the atom), followed by the name of the anion with the ending –***ide***.

MgO	magnesium ox***ide***
$CaCl_2$	calcium chlor***ide***

Type II:

- When naming compounds formed from these ions, include the ***ionic charge as Roman numeral***, in parentheses, after the metal's name.



- This method of nomenclature is called the "***stock***" system.

$\overset{?\ \ -1}{FeCl_2}$	$\overset{+2\ \ -1}{FeCl_2}$	Iron(II) chloride
$\overset{?\ \ -1}{FeCl_3}$	$\overset{+3\ \ -1}{FeCl_3}$	Iron(III) chloride
$\overset{?\ \ \ -2}{Cu_2O}$	$\overset{+1\ \ \ -2}{Cu_2O}$	Copper(I) oxide
$\overset{?\ \ -2}{CuO}$	$\overset{+2\ \ -2}{CuO}$	Copper(II) oxide

NAMING IONIC COMPOUNDS

Polyatomic Ions:

- Some ionic compounds contain ***polyatomic ions***, an ion composed of ***several atoms bound together***.
- Some common polyatomic ions are:

TABLE 3.5 Some Common Polyatomic Ions

Name	Formula	Name	Formula
Acetate	$C_2H_3O_2^-$	Hypochlorite	ClO^-
Carbonate	CO_3^{2-}	Chlorite	ClO_2^-
Hydrogen carbonate (or bicarbonate)	HCO_3^-	Chlorate	ClO_3^-
Hydroxide	OH^-	Perchlorate	ClO_4^-
Nitrite	NO_2^-	Permanganate	MnO_4^-
Nitrate	NO_3^-	Sulfite	SO_3^{2-}
Chromate	CrO_4^{2-}	Hydrogen sulfite (or bisulfite)	HSO_3^-
Dichromate	$Cr_2O_7^{2-}$	Sulfate	SO_4^{2-}
Phosphate	PO_4^{3-}	Hydrogen sulfate (or bisulfate)	HSO_4^-
Hydrogen phosphate	HPO_4^{2-}	Cyanide	CN^-
Dihydrogen phosphate	$H_2PO_4^-$	Peroxide	O_2^{2-}
Ammonium	NH_4^+		

- ***Polyatomic*** ionic compounds are named by naming the cation first, followed by the polyatomic ion.

Na_3PO_4	sodium phosphate
NH_4Br	ammonium bromide
$CuNO_3$	copper (I) nitrate
$Pb(CO_3)_2$	lead (IV) carbonate

Examples:

1. Name each of the following Type I ionic compounds:

   a) ZnS ________________

   b) Li_2O ________________

   c) Ca_3N_2 ________________

2. Name each of the following compounds using the stock nomenclature system:

   a) $SnCl_2$: ____________________ ______________________

   b) Cu_2S: _____________________ ______________________

3. Name the following polyatomic compounds:

   a) $Mg(OH)_2$: __________________

   b) $NaNO_3$: ____________________

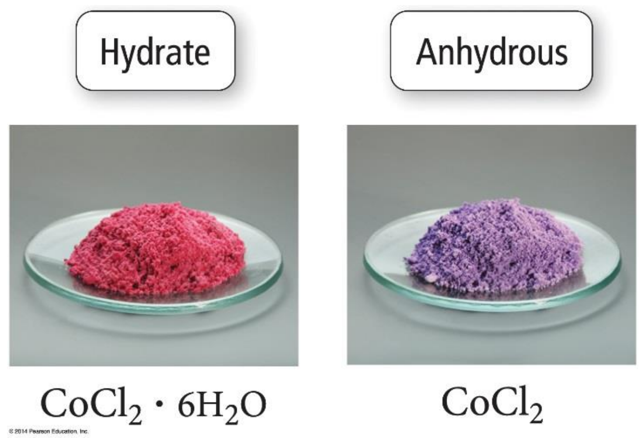
   c) $Fe_2(SO_4)_3$: __________________

HYDRATED IONIC COMPOUNDS

- Some ionic compounds– called hydrates–contain specific number of water molecules associated with each formula unit. Some examples of these compounds are listed below:

$$MgSO_4 \bullet 7\ H_2O$$
$$CoCl_2 \bullet 6\ H_2O$$
$$CuSO_4 \bullet 5\ H_2O$$

- The water molecules associated with these compounds are called ***water of hydration***, and can usually be removed by heating. After heating and removal of water, the salt remaining is called ***anhydrous*** salt.



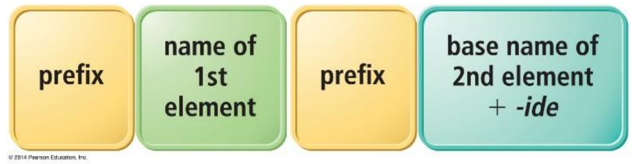
- Hydrates are named just as other ionic compounds, with an additional "*prefix*hydrate", where the *prefix* is the number of water molecules in the formula. For example:

$MgSO_4 \bullet 7\ H_2O$	magnesium sulfate heptahydrate
$CoCl_2 \bullet 6\ H_2O$	cobalt(II) chloride hexahydrate
$CuSO_4 \bullet 5\ H_2O$	copper(II) sulfate pentahydrate

NAMING & WRITING MOLECULAR FORMULAS

Binary Molecular Compounds:

- These compounds are named similar to ionic compounds, with the second element named based on its ***root*** and suffix ***"-ide".***



- ***Greek*** prefixes are used to indicate the ***number of atoms*** in these compounds:

Number	*Prefix*	*Number*	*Prefix*
1	mono-	6	hexa-
2	di-	7	hepta-
3	tri-	8	octa-
4	tetra-	9	nona-
5	penta-	10	deca-

CS_2 carbon ***di***sulf***ide***

PCl_5 phosphorus ***penta***chlor***ide***

N_2O_4 ***di***nitrogen ***tetr***ox***ide***

P_4O_{10} ***tetra*****phosphorous** ***dec*****oxide**

- The ***first atom*** uses a prefix only when ***more than one*** atom is present.

- The ***second atom always*** uses a prefix.

Examples:

1. Name the following molecular compounds:

   P_2O_5: ______________________

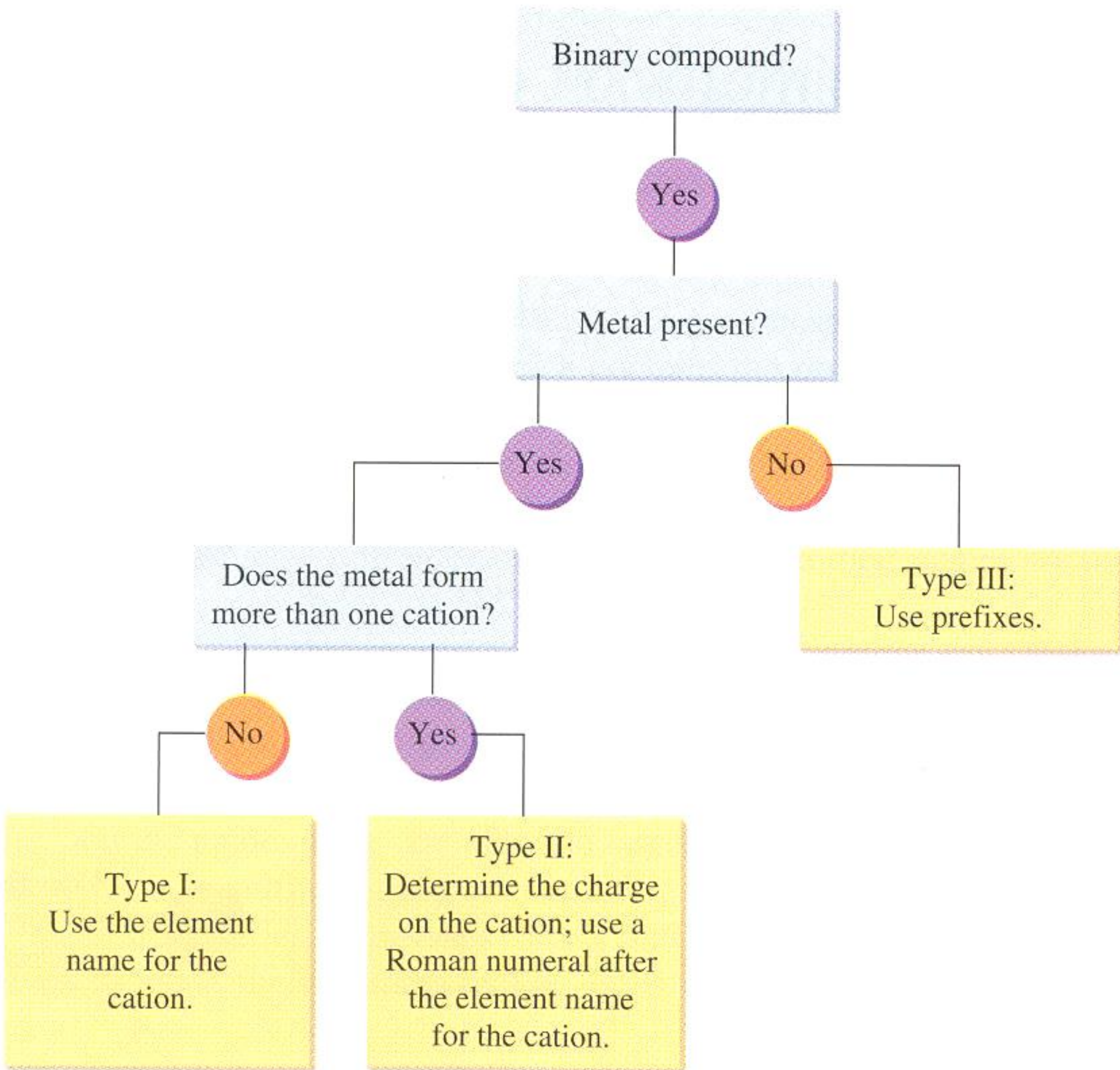
   IF_7: ______________________

2. Write formulas for the following molecular compounds:

   carbon tetrachloride: ______________

   dichlorine monoxide: ______________

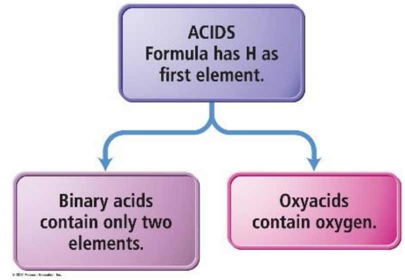
NOMENCLATURE FLOWCHART FOR BINARY COMPOUNDS



NAMING ACIDS

- Acids are molecular compounds that form ions when dissolved in water.

- Acids can be categorized into two groups: ***binary*** and ***oxyacids***.



Naming Binary Acids:

- Formulas are written similar to binary ionic compounds, assigning a +1 charge to hydrogen.

- When naming the acids, use **hydro-** prefix, followed by the name of the non-metal with an **–ic** ending, followed with the word **acid**.

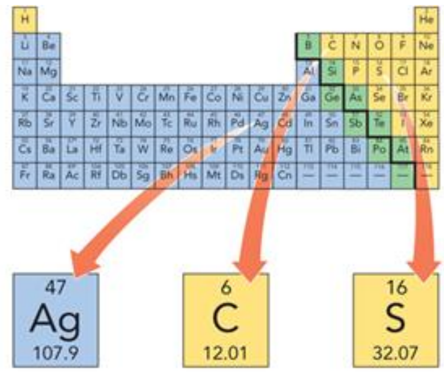
HCl	hydrochloric acid
H_2S	hydrosulfuric acid

Naming Oxyacids:

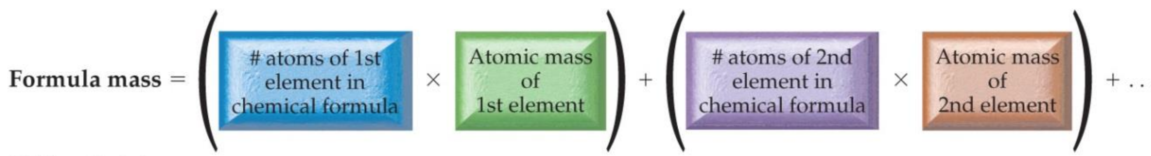
- Oxyacids are acids that contain oxyanions which are listed in the table of polyatomic ions. Some of the important acids in this group and the oxyanions they form are listed below.

Acid Name	Acid Formula	Oxyanion formed from ionization of acid
Nitric acid	HNO_3	NO_3^- (nitrate)
Nitrous acid	HNO_2	NO_2^- (nitrite)
Sulfuric acid	H_2SO_4	SO_4^{2-} (sulfate)
Sulfurous acid	H_2SO_3	SO_3^{2-} (sulfite)
Chloric acid	$HClO_3$	ClO_3^- (chlorate)
Chlorous acid	$HClO_2$	ClO_2^- (chlorite)
Phosphoric acid	H_3PO_4	PO_4^{3-} (phosphate)
Carbonic acid	H_2CO_3	CO_3^{2-} (carbonate) HCO_3^- (bicarbonate)
Acetic acid	$HC_2H_3O_2$	$C_2H_3O_2^-$ (acetate)

FORMULA MASS



- Recall that the atomic mass of elements was defined as average atomic mass of the isotopes that compose that element and measured in atomic mass unit (amu).
- Similarly, the formula mass of molecules or formula units can be defined as the sum of the atomic masses of all the atoms in its formula.



Mass of one molecule of CO_2

1 atom C = 1 (12.01 amu) = 12.01 amu
2 atom O = 2 (16.00 amu) = <u>32.00 amu</u>
44.01 amu **Formula Mass**

Mass of one formula unit of $Ca(OH)_2$

1 atom Ca = 1 (40.08 amu) = 40.08 amu
2 atoms O = 2 (16.00 amu) = 32.00 amu
2 atoms H = 2 (1.01 amu) = <u>2.02 amu</u>
74.10 amu **Formula Mass**

<u>Examples:</u>
Calculate the formula mass of each compound shown below:

1. Lithium sulfide, Li_2S

2. Aluminum nitrate, $Al(NO_3)_3$

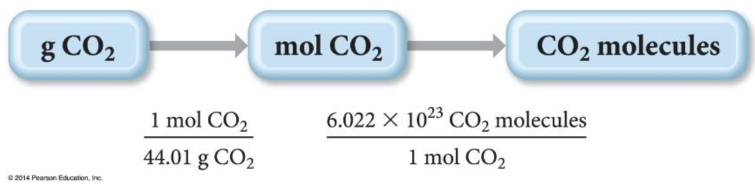
MOLAR MASS

- The molar mass of a compound–the mass in grams of one mole of its molecules or formula units–is numerically equivalent to its formula mass. For example:

Mass of one molecule of CO_2 = 44.01 amu

Mass of one mole of CO_2 = 44.01 g/mol

- Molar mass can be used as a conversion factor between mass (in grams) and amount (in moles), and Avogadro's number can be used to convert amount (in moles) to particles (in molecules). For example, 10.8 g of CO_2 can be converted to number of molecules as shown below:



$$10.8 \text{ g } CO_2 \text{ x } \frac{1 \text{ mol}}{44.01 \text{ g}} \text{ x } \frac{6.02\text{x}10^{23} \text{ molecules}}{1 \text{ mol}} = 1.48\text{x}10^{23} \text{ molecules } CO_2$$

Examples:

1. An aspirin tablet contains 325 mg of acetylsalicylic acid ($C_9H_8O_4$). How many acetylsalicylic acid molecules does it contain?

2. A sugar crystal contains approximately $1.8\text{x}10^{17}$ sucrose ($C_{12}H_{22}O_{11}$) molecules. What is its mass in mg?

MASS PERCENT

- The amount of an element in a compound can be expressed as ***its mass percent composition***, or ***mass percent***.

- Mass percent of element X in a compound can be calculated as shown below:

$$\text{Mass percent element X} = \frac{\text{mass of element X in 1 mol of compound}}{\text{mass of 1 mol of compound}} \text{x100\%}$$

- For example, the mass percent of Cl in the chlorofluorocarbon CCl_2F_2 can be calculated as shown below:

$$\text{Mass percent Cl} = \frac{\text{2 x molar mass of Cl}}{\text{molar mass of } CCl_2F_2} \text{x100\%} = \frac{\text{2 x 35.45 g/mol}}{\text{120.91 g/mol}} \text{x100\%} = 58.64\%$$

<u>Examples:</u>

1. Acetic acid ($C_2H_4O_2$) is the active ingredient in vinegar. Calculate the mass percent composition of oxygen in acetic acid.

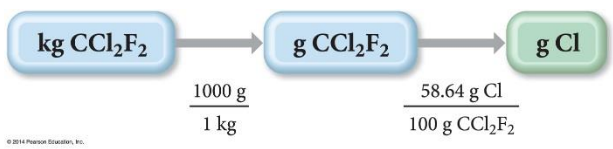
2. Calculate the mass percent composition of iron in siderite ($FeCO_3$), an iron ore.

MASS PERCENT AS A CONVERSION FACTOR

- The mass percent composition of an element in a compound is a conversion factor between mass of the element and the mass of the compound. For example, since the mass percent of Cl in CCl_2F_2 is 58.64%, the following conversion factors can be obtained from this information:

$$\frac{58.64 \text{ g Cl}}{100 \text{ g } CCl_2F_2} \quad \text{or} \quad \frac{100 \text{ g } CCl_2F_2}{58.64 \text{ g Cl}}$$

- These ratios can be used as conversion factors to convert grams of Cl and grams of CCl_2F_2. For example, the grams of Cl in 1.00 kg of CCl_2F_2 can be calculated as shown below:



$$1.00 \text{ kg } CCl_2F_2 \times \frac{1000 \text{ g}}{1 \text{ kg}} \times \frac{58.64 \text{ g Cl}}{100 \text{ g } CCl_2F_2} = 586 \text{ g Cl}$$

Examples:

1. What mass (in grams) of iron(III) oxide contains 58.7 g of iron? Iron(III) oxide is 69.94% iron by mass.

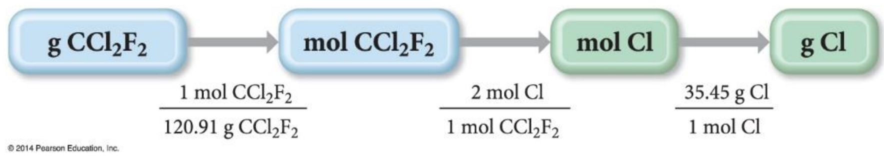
2. The ADA recommends that an adult female should consume 3.0 mg of fluoride (F^-) per day to prevent tooth decay. If the fluoride is consumed in form of sodium fluoride (45.24% F), what amount of sodium fluoride contains the recommended amount of fluoride?

CHEMICAL FORMULAS AS CONVERSION FACTORS

- Chemical formulas can be used to determine the mole ratios between the compound and its constituent elements. For example, the chemical formula for CCl_2F_2 can yield the following conversion factors:

$$\frac{1 \text{ mol C}}{1 \text{ mol } CCl_2F_2} \quad \text{and} \quad \frac{2 \text{ mol Cl}}{1 \text{ mol } CCl_2F_2} \quad \text{and} \quad \frac{2 \text{ mol F}}{1 \text{ mol } CCl_2F_2}$$

- Therefore, the mass of Cl in 25.0 g of CCl_2F_2 can be calculated as shown below:



$$25.0 \text{ g } CCl_2F_2 \times \frac{1 \text{ mol}}{120.91 \text{ g}} \times \frac{2 \text{ mol Cl}}{1 \text{ mol } CCl_2F_2} \times \frac{35.45 \text{ g}}{1 \text{ mol}} = 14.7 \text{ g Cl}$$

Examples:

1. Determine the mass of oxygen in 7.2 g of $Al_2(SO_4)_3$.

2. How many atoms of oxygen are present in 12.0 g of CO_2?

DETERMINING EMPIRICAL & MOLECULAR FORMULAS FROM EXPERIMENTAL DATA

- Since mass percent composition of elements can be found from the chemical formula, it would follow that the chemical formula for a compound can also be found from its mass percent composition. The formula found in this manner is the empirical formula for the compound.

- For example, aspirin is found the have the following mass percent composition:

60.00% C 4.48% H 35.52% O

- The empirical formula for aspirin, can then be generically assigned as:

$C_xH_yO_z$ where, x, y and z are molar ratios of each element

- Moles of each element can be found from its mass and molar mass:

$$60.00 \text{ g C x } \frac{1 \text{ mol}}{12.01 \text{ g C}} = 4.996 \text{ mol C}$$

$$4.48 \text{ g H x } \frac{1 \text{ mol}}{1.01 \text{ g H}} = 4.44 \text{ mol H}$$

$$35.52 \text{ g O x } \frac{1 \text{ mol}}{16.00 \text{ g O}} = 2.220 \text{ mol O}$$

- The mole ratio of each element can then be found, by dividing the mole of each by the smallest value:

$$\frac{4.996 \text{ mol C}}{2.220} = 2.25 \text{ mol C}$$

$$\frac{4.44 \text{ mol H}}{2.220} = 2.00 \text{ mol H}$$

$$\frac{2.220 \text{ mol O}}{2.220} = 1.00 \text{ mol O}$$

- Since mole ratio of elements cannot be fractional, these ratios are multiplied by a factor to become whole numbers:

2.25 mol C x 4 = 9 mol C

2.00 mol H x 4 = 8 mol H

1.00 mol O x 4 = 4 mol O

The empirical formula is

$C_9H_8O_4$

DETERMINING EMPIRICAL & MOLECULAR FORMULAS FROM EXPERIMENTAL DATA

- Molecular formulas can be determined from the empirical formula and molar mass of the compound, as indicated below:

$$\text{Molecular formula} = (\text{empirical formula}) \times (n), \quad \text{where } n = 1, 2, 3 \ldots.$$

$$n = \frac{\text{molar mass of compound}}{\text{molar mass of empirical formula}}$$

- For example, fructose has an empirical formula of CH_2O and molar mass of 180.2 g/mol. The molecular formula for fructose can then be found as shown below:

$$n = \frac{180.2 \text{ g/mol}}{30.03 \text{ g/mol}} = 6$$

$$\text{Molecular formula} = (CH_2O) \times 6 = C_6H_{12}O_6$$

Examples:

1. Butanedione has an empirical formula of C_2H_3O and molar mass of 86.09 g/mol. What is the molecular formula for butanedione?

2. A compound has mass percent composition shown below and molar mass of 60.10 g/mol. Determine its empirical and molecular formulas.

39.97% C 13.41% H 46.62% N

COMBUSTION ANALYSIS

- A common method of obtaining empirical and molecular formulas for unknown compounds, especially those containing carbon and hydrogen (hydrocarbons) is combustion analysis.

- In this technique, the unknown compounds undergoes combustion, in presence of oxygen, with all of its carbon converted to CO_2 and all of its hydrogen converted to H_2O.

- The numerical relationships between moles inherent in the formula for CO_2 and H_2O allows one to determine the amounts of C and H in the original sample. The amount of any other element, such as O, Cl or N can be found by difference between the total mass of sample and mass of C and H.

Examples:

1. Upon combustion, a compound containing only C and H produces 1.83 g of CO_2 and 0.901 g of H_2O. Find the empirical formula for this compound.

2. Upon combustion, a 0.8233 g of an unknown compound containing only C, H and O produces 2.445 g of CO_2 and 0.6003 g of H_2O. Find the empirical formula for this compound.

WRITING & BALANCING EQUATIONS

- Chemical reactions are represented by a chemical equation.. For example, the combustion of methane is represented by the skeletal equation shown below:

$$\underset{\text{reactants}}{CH_4 + O_2} \rightarrow \underset{\text{products}}{CO_2 + H_2O}$$

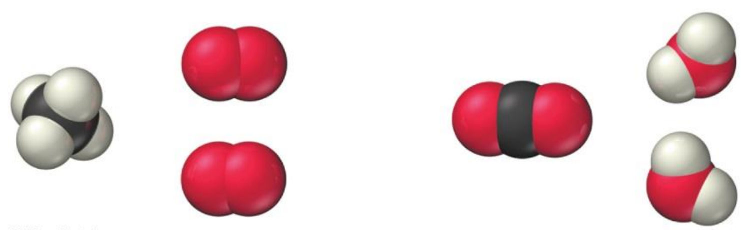
- The state of each substance is specified by an abbreviation in parenthesis next to its formula:

$$CH_4\,(g) + O_2\,(g) \rightarrow CO_2\,(g) + H_2O\,(g)$$

Abbreviation	State
(*g*)	Gas
(*l*)	Liquid
(*s*)	Solid
(*aq*)	Aqueous (water solution)

- The number of atoms on each side of the equation can be balanced by placing coefficients in front of each substance.

$$CH_4(g) + 2\,O_2(g) \longrightarrow CO_2(g) + 2\,H_2O(g)$$



- To write a balanced chemical equation, the following guideline is useful:

1. Write a skeletal equation by writing chemical formulas for each reactant and product. Be sure each formula is correct by following nomenclature rules discussed earlier in this chapter.

2. Balance atoms that occur in more complex substances first. Always balance atoms in compounds first before atoms in elements.

3. Balance atoms that occur as free elements last by adjusting the coefficient on the free element.

4. If the balanced equation contains coefficients that are multiples or fractions, use a proper factor to make them the smallest possible integers.

5. Check to make sure equation is balanced by summing the total number of each atom on both sides of the equation.

WRITING & BALANCING EQUATIONS

Examples:

1. Write a balanced equation for the reaction between solid cobalt(III) oxide and solid carbon to form solid cobalt and carbon dioxide.

Step 1: $Co_2O_3\,(s) \;+\; C\,(s) \;\rightarrow\; Co\,(s) \;+\; CO_2\,(g)$

Step 2: $Co_2O_3\,(s) \;+\; C\,(s) \;\rightarrow\; Co\,(s) \;+\; CO_2\,(g)$

Step 3: $Co_2O_3\,(s) \;+\; C\,(s) \;\rightarrow\; Co\,(s) \;+\; CO_2\,(g)$

Step 4:

Step 5:

2. Write a balanced equation for the reaction between aqueous strontium chloride and aqueous lithium phosphate to form solid strontium phosphate and aqueous lithium chloride.

Step 1:

Step 2:

Step 3:

Step 4:

Step 5:

Answers to In-Chapter Problems:

Page	Example No.	Answer
3	1	a) CH_2 b) CCl_4 c) BH_3
6	1	a) atomic element d) molecular compound b) ionic compound e) ionic compound c) molecular element
	2	a) ionic compound c) molecular compound b) molecular element
8	1	a) $CaCl_2$ d) Ca_3P b) Na_2S e) Fe_2S_3 c) AlN
11	1	a) zinc sulfide b) lithium oxide c) calcium nitride
	2	a) tin(II) chloride (stannous chloride)
		b) copper(I) sulfide (cuprous sulfide)
	3	a) magnesium hydroxide c) iron(III) sulfate b) Sodium nitrate
13	1	diphosphorous pentoxide iodine heptafluoride
	2	CCl_4 Cl_2O
16	1	45.94 amu
	2	213.01 amu
17	1	$1.09x10^{21}$
	2	0.10 mg
18	1	53.29%
	2	48.20%
19	1	83.9 g
	2	$6.6x10^{-3}$ g
20	1	4.0 g
	2	$3.28x10^{23}$
22	1	$C_4H_6O_2$
	2	CH_4N
23	1	C_5H_{12}
	2	$C_{10}H_{12}O$
25	1	$2\ Co_2O_3\ (s) + 3\ C\ (s) \rightarrow 4\ Co\ (s) + 3\ CO_2\ (g)$
	2	$3\ SrCl_2\ (aq) + 2\ Li_3PO_4\ (aq) \rightarrow Sr_3\ (PO_4)_2\ (s) + 6\ LiCl\ (aq)$