Chapters 4 and 5

Goals:

- ✓ Be able to write formulas and names for elements, ions, ionic compounds, molecular compounds and acids.
- ✓ Memorize 14 designated polyatomic ions from table 4.3.
- ✓ Memorize the 7 elements that exist in diatomic form.
- ✓ Memorize 10 designated prefixes for naming molecular compounds.
- ✓ Know what combination of atoms will result in formation of an ionic versus a molecular compound.

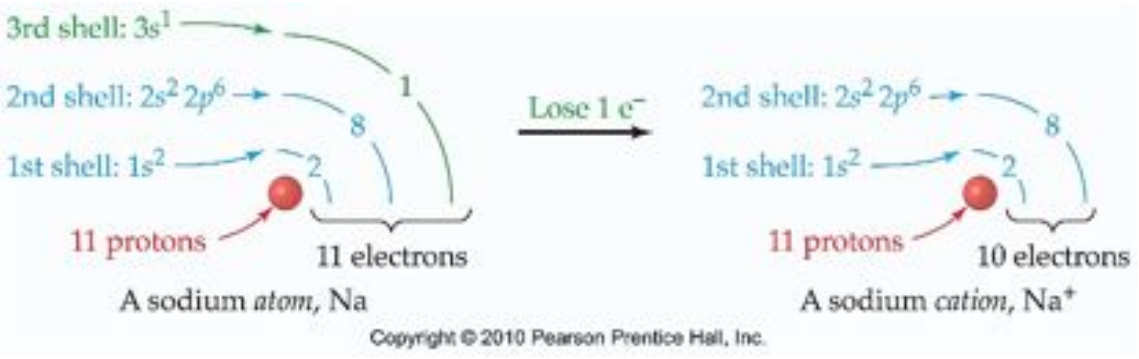
Naming Cations

Cations: When a metal loses it's valence electron(s) it becomes a cation, which is an ion with a positive charge.

- Loss of electrons is known as oxidation.
- A metal will usually lose all valence electrons when oxidized. Since the number of valence electrons is equal to the group number, it is easy to predict the number of electrons that will be lost from an atom by looking at the group number.
- The cation is named by using the element name followed by the word "ion".

Examples:

- Sodium is in group 1, and it will lose 1 electron to form the cation Na^+, known as a sodium ion.
- Calcium is in group 2, and it will lose 2 electrons to form the cation Ca^{2+}, known as a calcium ion.



NOTE: Metals in group 4A (Sn and Pb) can lose either 2 or 4 electrons. Transition elements can have more then one oxidation state as well, but we will not worry about transition metals in Chemistry 30A.

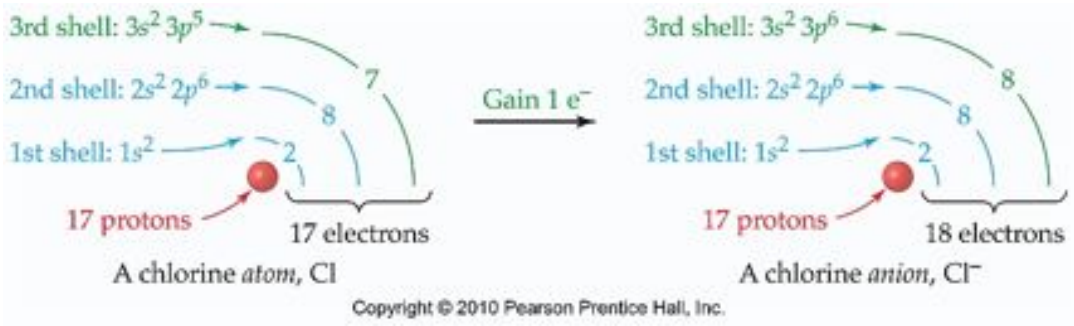
Naming Anions

Anions: When a nonmetal gains a valence electron(s) it becomes an anion, which is an ion with a negative charge.

- Gain of electrons is known as reduction.
- A nonmetals will usually gain the number of electrons equal to their group number subtracted from 8 when reduced.
- The anion is named by using the stem of the element name with an –ide ending.

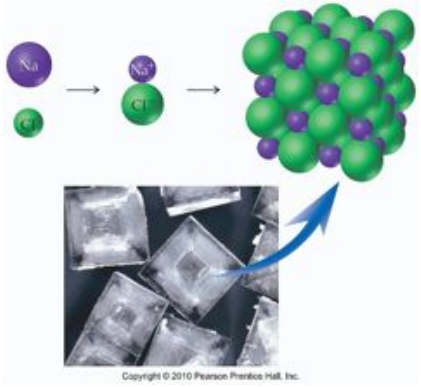
Examples:

- Fluorine is in group 7, and it will gain 1 electron to form F^-, which is known as a flouride ion.
- Oxygen is in group 6, and it will gain 2 electrons to form O^{2-}, which is known as an oxide ion.



Naming Ionic Compounds

Ionic compounds are formed when electrons are transferred between atoms in order to achieve a stable configuration; ions are formed, but the overall charge on the compound is neutral. Ionic compounds are held together by electrostatic forces of attraction, and are typically formed when metals react with nonmetals.



Binary Ionic Compounds: contain only one type of metal and one type of nonmetal.

Formula to name:

- Write the name of the cation (use roman numeral if necessary)
- Write the name of the anion (use the –ide ending)

Example:

Na_2S is named as sodium sulfide

Problems:

1. MgO
2. $CaBr_2$

Naming Ionic Compounds Continued

Name to formula:

- Determine the charge on the cation
- Determine the charge on the anion
- Determine the ratio of cations to anions needed to make the compound neutral
- Always express the ratio of cations to anions in the simplest whole number ratio

Examples:

- Lithium fluoride is composed of Li^+ and F^-; this forms the compound LiF
- Magnesium bromide is composed of Mg^{2+} and Br^-; this forms the compound $MgBr_2$
- Aluminum chloride is composed of Al^{3+} and Cl^-; this forms the compound $AlCl_3$

Problems:

1) Magnesium oxide
2) Potassium iodide
3) Tin (II) oxide

Polyatomic Ions

Polyatomic Ions: are ions that contain two or more atoms (a group of atoms) with an overall charge. Polyatomic ions are held together by covalent bonds (to be discussed later), but they have an overall charge which makes them ions.

TABLE 4.3 Some Common Polyatomic Ions

NAME	FORMULA	NAME	FORMULA
Hydronium ion	H_3O^+	Nitrate ion	NO_3^-
Ammonium ion	NH_4^+	Nitrite ion	NO_2^-
Acetate ion	$CH_3CO_2^-$	Oxalate ion	$C_2O_4^{2-}$
Carbonate ion	CO_3^{2-}	Permanganate ion	MnO_4^-
Hydrogen carbonate ion (bicarbonate ion)	HCO_3^-	Phosphate ion	PO_4^{3-}
		Hydrogen phosphate ion	HPO_4^{2-}
Chromate ion	CrO_4^{2-}	Dihydrogen phosphate ion	$H_2PO_4^-$
Dichromate ion	$Cr_2O_7^{2-}$	Sulfate ion	SO_4^{2-}
Cyanide ion	CN^-	Hydrogen sulfate ion (bisulfate ion)	HSO_4^-
Hydroxide ion	OH^-		
Hypochlorite ion	OCl^-	Sulfite ion	SO_3^{2-}

Naming Ionic Compounds with Polyatomic Ions

Formula to Name:

- Write the name of the cation (use roman numeral if necessary)
- Write the name of the anion (from the chart/memory)

Examples:

- $Ca_3(PO_4)_2$ is named as calcium phosphate
- $PbSO_4$ is named as lead (II) sulfate

Problem:

1) $NaHCO_3$

Name to Formula:

- Determine the charge on the cation
- Determine the charge on the anion
- Determine the ratio of cations to anions needed to make the compound neutral
- Always express the ratio of cations to anions in the simplest whole number ratio
- If there is more then one polyatomic ion use parenthesis and write the subscript outside the last parenthesis

Examples:

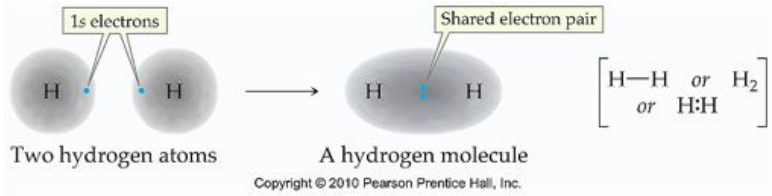
- Magnesium nitrate has the formula $Mg(NO_3)_2$
- Iron (II) sulfate has the formula $FeSO_4$
- Iron (III) sulfate has the formula $Fe_2(SO_4)_3$

Problems:

1) Potassium sulfate
2) Sodium nitrite

Naming Molecular Compounds

Molecular Compounds: form when electrons are shared between nonmetals in order to achieve octet; held together by covalent (aka: molecular) bonds. Typically formed between nonmetals only.



- There are seven elements that exist in nature as diatomic molecules: H_2, F_2, Cl_2, Br_2, I_2, N_2, O_2

- When there are two or more different types of atoms in a molecular compound, use prefixes to tell how many atoms of each element are present.

TABLE 5.2 Numerical Prefixes Used in Chemical Names

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

Naming Molecular Compounds

Formula to Name:

- Write the name of the leftmost nonmetal using the appropriate prefix; if there is only one of the first element the mono prefix is dropped.
- Write the stem of the rightmost nonmetal with the –ide ending using the appropriate prefix; do not drop the mono prefix
- ao is written as o; oo is written as o; ii is written as ii

Examples:

- SF_6 is named as sulfur hexafluoride
- N_2O_4 is named as dinitrogen tetroxide

Problem:

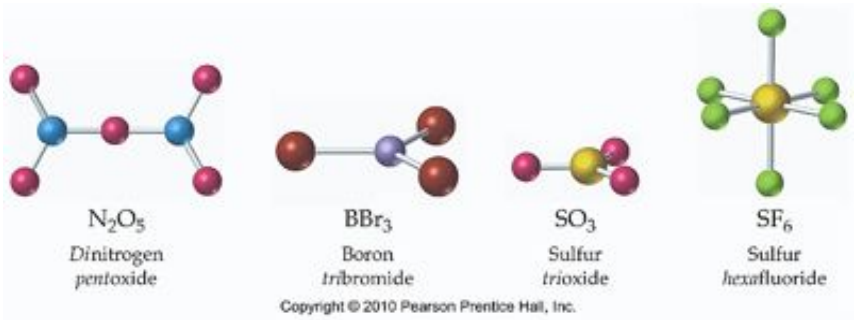
1) NI_3

Examples:

- Carbon monoxide is written as the formula CO
- Silicon tetrachloride is written as $SiCl_4$

Problem:

1) Iodine heptachloride



Ionic Versus Molecular Compounds

Ionic compounds are composed of ions. The ratio of cations to anions is always expressed in the simplest whole number ratio known as a **formula unit**.

Examples:

NaCl

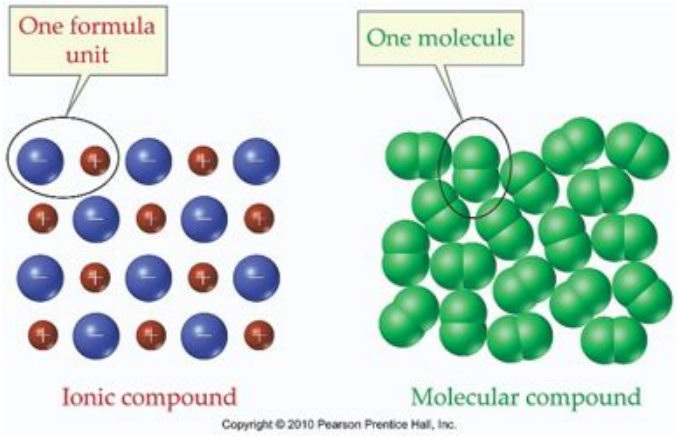
$CaBr_2$

The formula for a molecular compound shows the number of atoms that are combined in one **molecule** of the compound. Molecular formulas are not necessarily expressed in the simplest whole number ratio of atoms.

Examples:

NO

N_2O_4



Naming Common Acids

Acid: An acid is a substance that is capable of donating a hydrogen ion.

Binary Acids:

- HF
- HI
- HCl
- HBr

Oxyacids:

- H_2SO_4
- H_2SO_3
- HNO_3
- HNO_2
- H_2CO_3
- H_3PO_4
- $HC_2H_3O_2$

Should Dihydrogen Monoxide (DHMO) Be Banned?

DHMO is a colorless, odorless, tasteless compound that is a liquid at room temperature. It is found in nature in the solid, liquid and gaseous state. DHMO commonly causes death by accidental inhalation. Other affects of DHMO include:

- Tissue damage from prolonged exposure to solid DHMO
- Sweating, bloating, vomiting, and urination from excess consumption of DHMO
- Severe burns from exposure to gaseous DHMO
- DHMO is a major component of acid rain
- DHMO is a contributor to global warming
- DHMO is found in biopsies of pre-cancerous tumors

A number of people have taken action to ban DHMO by signing petitions. What is the chemical formula of DHMO?

NOTE: Additional practice problems will be covered in the "Nomenclature Worksheet" in lab.