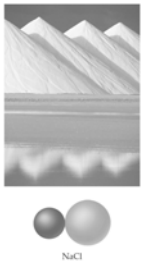
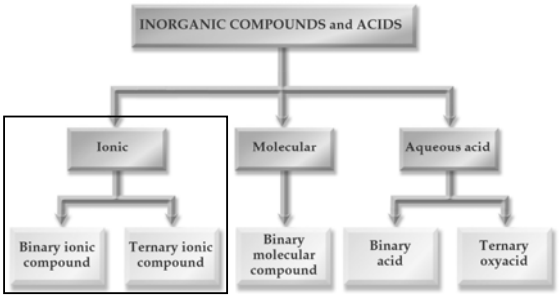
Chapter 5
Ionic Compounds



Classification of Compounds

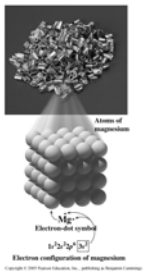


Chemical Nomenclature

- The term "nomenclature" come from the Latin word meaning "calling by name".
- **Chemical Nomenclature** is a system for naming chemical compounds.
- In this chapter we will learn a system for naming compounds from their formula and writing the chemical formula from the name.
- You will have to memorize some things (polyatomic ions for example), but if you learn the system, you will be able to name numerous chemical compounds by only seeing the formula.
- Do be successful you must **LEARN THE SYSTEM!!!**

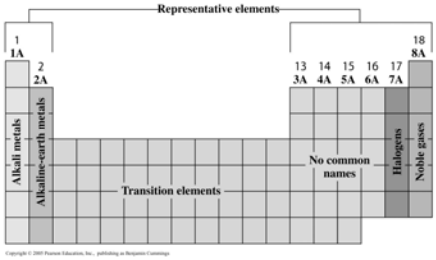
Valence Electrons

- When an atom undergoes a chemical reaction, only the outermost electrons are involved.
- These electrons are of the highest energy and are furthest away from the nucleus. These are the ***valence electrons***.
- The valence electrons are the *s* and *p* electrons beyond the noble gas core.



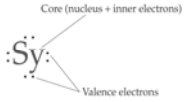
Predicting Valence Electrons

- The Group number indicates the number of valence electrons.

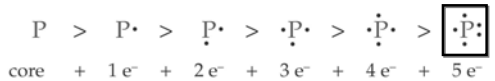


Electron Dot Formulas

- An electron dot formula of an elements shows the symbol of the element surrounded by its valence electrons.
- We use one dot for each valence electron.



- Consider phosphorous, P, which has 5 valence electrons. Here is the method for writing the electron dot formula.



Drawing Electron Dot Formulas

Lets look at **Oxygen** as an example

Step 1: Write the symbol of the element to represent the core of the atom.

O

Step 2: Determine the number of valence electrons for the element in question from the group number in the periodic table.

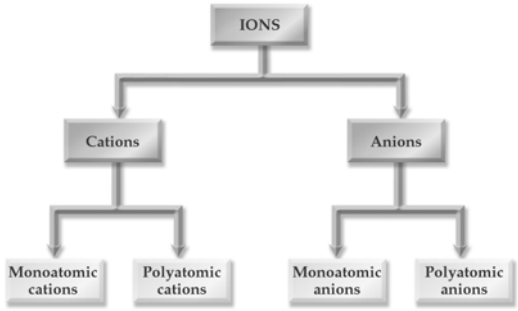
Oxygen is in **group 6A** on the periodic table so it has **6 valence electrons**

Step 3: Draw one dot on each of the four sides of the element symbol then double up until you use all of the valence electrons.

First 4 valence electrons

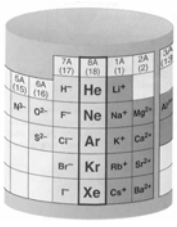
Last 2 valence electrons to give 6 total

Classification of Ions



Everyone Wants to be a Nobel Gas: Predicting Ionic Charge

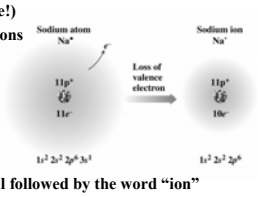
- **Metals** can **lose their valence electrons**, achieve a noble gas configuration.
- Similarly, **nonmetals** can **gain electrons** to achieve a noble gas configuration.
- Metals form ***cations*** and non-metals form ***anions***
  - Cations are positively charged ions
  - Anions are negatively charged ions
- You can determine the ionic charge of an ion of a main group element by looking at its group number.
  - **Cations** have the same charge as their **group number**
  - **Anions** have a charge that is equal to their **group number minus 8**



Monoatomic Cations

- **Metals form cations with octets by *losing* all of their valence electrons**
- **These cations have the same electron configuration as the nearest noble gas (the one at the end of the row above!)**
- **Cations have fewer electrons than protons**

Group 1A metals ⟶ ion 1^+
Group 2A metals ⟶ ion 2^+
Group 3A metals ⟶ ion 3^+



- **Cations are named for the parent metal followed by the word "ion"**

Na^+ is the Sodium Ion
Ca^{2+} is the Calcium Ion

Metals That Form Multiple Cations

- Some of the transition metals can form **more than one** cation
- These cations are named for the parent, followed by the charge in Roman numerals in parentheses followed by the word "ion".

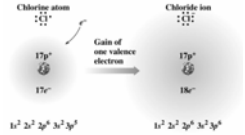
Fe^{2+} is the iron(II) ion
Fe^{3+} is the iron(III) ion

- This is called the ***Stock system*** of naming cations.
- **Silver ion (Ag^+), Zinc ion (Zn^{2+}), Nickel ion (Ni^{2+}) and Cadmium ion (Cd^{2+})** are exceptions because they only form one ion! Memorize these!
- You will always be able to determine the charge of a transition metal from its name or formula!

Monoatomic Anions

- Nonmetals form anions with full octets by **gaining** electrons
- These anions have the same electron configuration as the nearest noble gas (the one at the end of the row they are in!)
- Anions have more electrons than protons

Group 7A nonmetals ⟶ ion 1^-
Group 6A nonmetals ⟶ ion 2^-
Group 5A nonmetals ⟶ ion 3^-

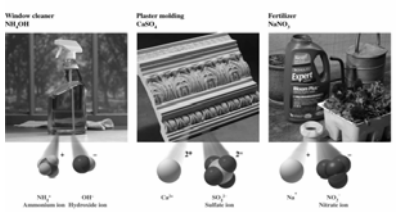


- Monoatomic anions are named by dropping the end of the element name and adding the suffix *–ide*.

Br^- is the bromide ion
O^{2-} is the oxide ion
N^{3-} is the nitride ion

Polyatomic Ions

- A Polyatomic Ions are a group of atoms that has an overall charge
- These ions are generally anions and contain one or more elements combined with oxygen



Common Polyatomic Ions

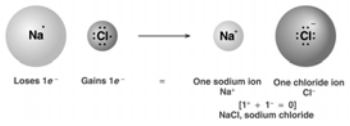
Symbol	Name	Symbol	Name
NO_3^-	Nitrate	ClO_4^-	Perchlorate
NO_2^-	Nitrite	ClO_3^-	Chlorate
SO_4^{2-}	Sulfate	OH^-	Hydroxide
SO_3^{2-}	Sulfite	MnO_4^-	Permanganate
CN^-	Cyanide	$Cr_2O_7^{2-}$	Dichromate
PO_4^{3-}	Phosphate	CrO_4^{2-}	Chromate
CO_3^{2-}	Carbonate	NH_4^+	Ammonium
HCO_3^-	Hydrogen Carbonate	H_3O^+	Hydronium
$C_2H_3O_2^-$	Acetate	**Also look at Table 5.8 in Chapter 5!!**	

You need to memorize the ones above!!

Ionic Compounds

- Ionic compounds consist of positive and negative ions.
- An ionic bond is an attraction between the positive and negative charges.
- In an ionic formula, the total charge of the positive ions is equal to the total charge of the negative ions.

total positive charge = total negative charge



Writing Ionic Formulas

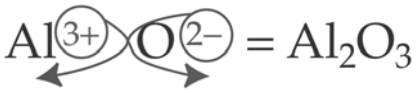
- An ionic compound is composed of positive and negative ions (cations and anions).
- A ***formula unit*** is the simplest representative particle of an ionic compound.
- A formula unit is neutral, so the total positive charge (cation) must equal the total negative charge (anion) in the formula unit.

total positive charge = total negative charge

- When writing chemical formulas, the chemical symbol for the cation (metal) goes first and then the anion (non-metal). (Either can be a polyatomic ion!)

Crossover Rule

- You can quickly determine the chemical formula for ionic compounds by using the crossover rule.
- All you do is cross over the charge on one ion to determine the subscript of the other ion and vice versa.
- For example, the charge on the aluminum ion becomes the subscript for the oxygen, and the charge on the oxide ion becomes the subscript for the aluminum ion.



Writing Formulas of Ionic Compounds

- To write the formula of an ionic compound following these rules:

Rule 1: Determine the charge on the cation and on the anion

Rule 2: Crisscross these charges so that the charge of the cation becomes the subscript of the anion and vice versa. If one of the ions is a polyatomic ion you must place it in **parentheses** then place the subscript outside.

Rule 3: Put the formula together by writing the cation first with its subscript then the anion with its subscript

Rule 4: Make sure that the final formula has the smallest possible subscripts. If the subscripts are both divisible by a common number you must do this division then re-write the formula

Naming Binary Ionic Compounds

Guide to Naming Ionic Compounds with Metals That Form a Single Ion

STEP 1
Identify the cation and anion.

STEP 2
Name the cation by its element name.

STEP 3
Name the anion by changing the last part of its element name to ide.

STEP 4
Write the name of the cation first and the name of the anion second.

Naming Binary Ionic Compounds: Transition Metals

Guide to Naming Ionic Compounds with Variable Charge Metals

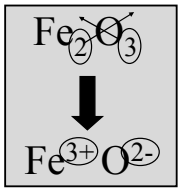
STEP 1
Determine the charge of the cation from the anion.

STEP 2
Name the cation by its element name and a Roman numeral in parentheses for the charge.

STEP 3
Name the anion by changing the last part of its element name to ide.

STEP 4
Write the name of the cation first and the name of the anion second.

Reverse the criss-cross!



Practice, Practice, Practice!!!!

	OH^-	NO_2^-	CO_3^{2-}	HSO_4^-	PO_4^{3-}
Li^+					
Cu^{2+}					
Ba^{2+}					

Silver permanganate _____

Cadmium sulfide _____

Cobalt (III) iodide _____

Zinc sulfate _____

Barium fluoride _____

Sodium acetate _____