Chapter 6 and 15
Ionic Compounds

Chapter 6 Ionic compounds 6.3, 6.4

6.1: Intro to Chemical Bonding

A **chemical bond** is a mutual electrical attraction between the nuclei and valence electrons of different atoms that binds the atoms together.

There are two types of bonding:

- **Ionic bonding** is bonding that results from the electrical attraction between anions and cations
- **Covalent bonding** results from the sharing of electron pairs between two atoms

Formula Unit:

Is used to represent an ionic compound

A formula unit represents the lowest whole number ratio in a compound

- There is no such thing as a molecule of sodium chloride
- ***Ionic compounds exist as a collection of positively and negatively charged ions arranged in repeating 3-D patterns***

Chemical Bonding

- An electrostatic force of attraction between two atoms, ions, or molecules
- Opposite charges attract and like charges repel.
- Ionic compounds exist as 3-dimensional arrays of ions held together by the force of attraction between the oppositely charged ions.

Section 6.3: Ionic Bonding

An **ionic compound** is composed of anions and cations combined so that the numbers of positive and negative charges are equal.

- Compounds are comprised of metal-nonmetal bonding
- A **formula unit** shows the lowest whole number ratio of atoms in an ionic compound.

Ionic Compounds

Ionic Compounds are **neutral**

- Combine a cation and an anion
- Cation + Anion → Neutral ionic compound

$$A^+ + X^- \rightarrow AX$$

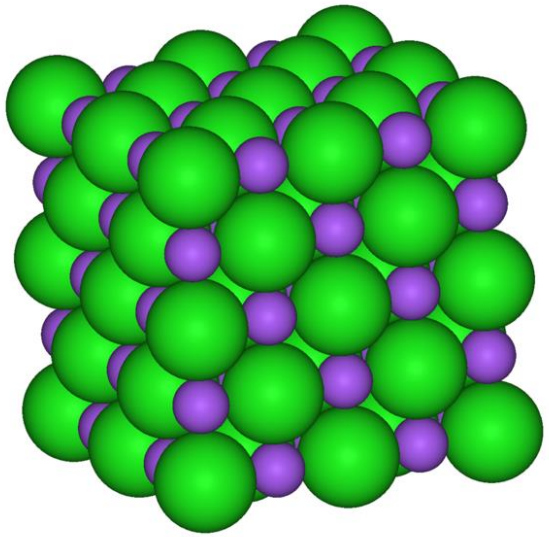
Properties of Ionic Compounds

- Repeating 3D patterns
- Most are crystalline solids at room temp
- Characteristics
  - High melting points
  - Conductivity in molten states
  - Existence in crystalline form
  - Tendency to dissolve in water
  - Produce electrical conductivity when dissolved in water

Coordination Number

Definition – gives the number of ions of opposite charge that surround each ion in a crystal

- Example: NaCl
- Coordination # = 6



Formula Unit:

Used to represent an ionic compound

- Is the lowest whole number ratio in the compound

Table Salt (sodium chloride): NaCl

Lowest whole number ratio = 1:1

- One sodium to each chloride

Ionic Charges

For "A" Group Metals:

Group **1A**: Alkali metals

- Li, Na, K = 1+

Group **2A**: Alkaline earth metals

- Mg, Ca = 2+

Group **3A**: Other metals

- Al(only metal) = 3+

Ionic Charges:

For "A" Group Nonmetals:

The charge is determined by subtracting 8 from the group number

- Example Group 7A elements
- F : 7- 8 = -1
- Group 7A elements form -1 ions

Ionic Charges:

Group **6A:** Oxygen family

- O, S = (6 – 8 = -2)

Group **5A:** Nitrogen family

- N = (5 – 8 = -3)

Group **7A:** Halogens

- Cl = (7-8 = -1)

Ionic Charges:

Group 0 (really group 8A) and Group 4A usually do not form ions

- Group 8- noble gases
- Group 4A- nonmetals form molecular compounds

Ionic Charges:

Stock system:

- For naming cations with more than one possible charge
- Example: **Iron**
  - Has two possibilities (+2), (+3)
  - Written as Iron(II) ion (Fe^{2+}) and Iron(III) ion (Fe^{3+})

Ionic Charges:

Can also use the root word with a different suffix to designate between multiple charged cations:

- Example: Iron(II): *ferrous* (Fe^{2+})
- Iron(III): *ferric* (Fe^{3+})

Other Ions

Polyatomic ions – ions that are made up of more then one atom

- Behave like atoms
- Tightly bound groups
- Very common & stable in nature
- Have special names:
- Ammonium = NH_4^+

Polyatomic ions:

Most end in *–ite*, or *–ate*

- Exceptions:
  - Ammon*ium* (NH_4^+)
  - Hydrox*ide* (OH^-)
  - Cyan*ide* (CN^-)

Polyatomic ions:

Polyatomic ions with hydrogen:

- Example: HCO_3^-
  - $H^+ \quad + \quad CO_3^{2-}$
  - *Note*: the charge of the new ion is the sum of the charges of the composite ions

Ionic Compounds:

For All Ionic Formulas:

- The positive charge of the cation balances the negative charge of the anion
- Net ionic charge of formula must = zero

Binary ionic compounds:

- Composed of only two elements: a non- metallic element and a metallic element
- Ionic charges used to assign **formulas** and **names**

Rules for Naming Binary Compounds

1. Write the name of the cation (usually a metal ion)
   - If the cation is a transition metal, use a Roman numeral for the charge
2. Write the name of the non-metal with an **–ide** ending

Binary compounds

1. $CaBr_2$
   - Calcium Bromide
1. NaCl
   - Sodium Chloride
2. KCl
   - Potassium Chloride

Naming Binary Compounds

Example: CuO

- Copper is a transition metal
- Copper has two possibilities:
  - Copper (I) and Copper (II)
- Since oxygen is -2, Cu is +2
- So the name is **Copper(II) oxide**

Writing Ionic Formulas From Names

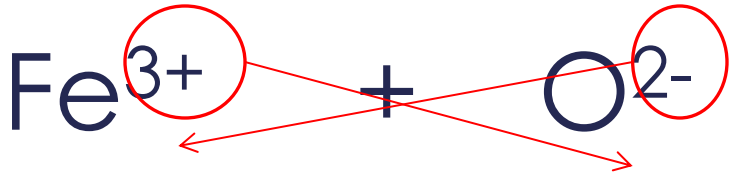
Ionic Compounds:

Crisscross method:

- The numerical charge of each ion is crossed over and used as a subscript for the other ion
- The signs of the numbers are dropped

Ionic Compounds:

- Example: iron (III) oxide



- To write the formula use the crisscross method:

Fe_2O_3

Ternary Ionic Compounds:

Ionic compound that contains atoms of three different elements

- Usually contain a polyatomic ion
- Use the same procedure for writing formulas as binary compounds

Ternary Ionic Compounds:

Example:

Sodium carbonate

Na^{+1} and CO_3^{2-}

Formula:

Na_2CO_3

Ternary Ionic Compounds:

Example: Calcium Nitrate

- Ca^{2+} + NO_3^-

Use crisscross method

$Ca(NO_3)_2$

Parenthesis indicates two nitrate ions

Molecular Acids

Molecular Common Acids

Acids: molecular substances that release hydrogen ions when dissolved in water

- They are composed of H^+ ion combined with any anion (negative ion). They are named by modifying the name of the anion.

Naming Common Acids

The cation is always hydrogen

- The formulas have as many hydrogens as needed to make the compound electrically neutral
  - HCl
  - H_2CO_3

Naming Acids

Anion ends with:	Change ending to:
-ate	-ic acid
-ite	-ous acid
-ide	Hydro- ____ -ic acid

I ***ATE*** something ***IC***ky in the cafeteria
I b***ITE*** a delici***OUS*** apple

Writing Formulas

Write formulas exactly like ionic compounds.

Anion	Formula	Name
Cl^- Chloride ion	HCl	Hydrochloric acid
ClO_3^- Chlorate	$HClO_3$	Chloric acid
ClO_2^- Chlorite	$HClO_2$	Chlorous acid

Six Common Acids:

- Hydrochloric acid: HCl
- Sulfuric acid: H_2SO_4
- Nitric acid: HNO_3
- Acetic acid: $HC_2H_3O_2$
- Phosphoric acid: H_3PO_4
- Carbonic acid H_2CO_3