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Objectives for Unit 4

- To be able to name or give the formula of binary molecular compounds.
- To be able to name or give the formula of ionic compounds.
- To be able to recognize the formula for a hydrate.
- To be able to recognize and name Arrhenius acids and bases.

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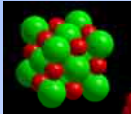
INTRODUCTION TO NOMENCLATURE

In chemistry we consider atoms as being the building blocks of all the matter that we study. Just like Legos are put together to make different shapes, atoms combine to make different material. In order to understand how atoms do this, we need to learn about **CHEMICAL BONDING**.




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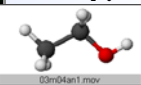
**Covalent and Ionic Compounds
or called
Particles & Molecules**



NaCl, salt



Buckyball, C₆₀



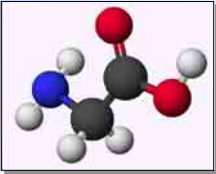
Ethanol, C₂H₆O

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MOLECULAR FORMULAS

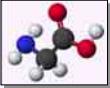
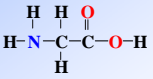
- Formula for glycine is $C_2H_5NO_2$
- In one molecule there are
 - 2 C atoms
 - 5 H atoms
 - 1 N atom
 - 2 O atoms



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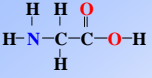
WRITING FORMULAS

- Can also write glycine formula as $-H_2NCH_2COOH$ to show atom ordering
- or in the form of a **structural formula**




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MOLECULAR MODELING



Drawing of glycine

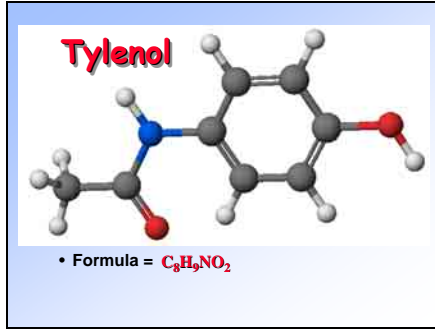


Ball & stick

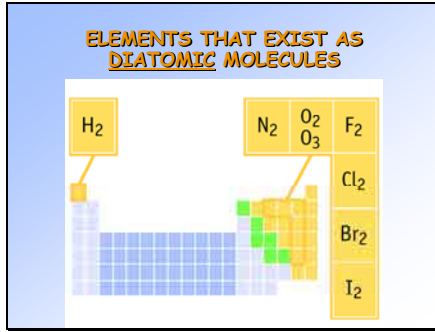


Space-filling

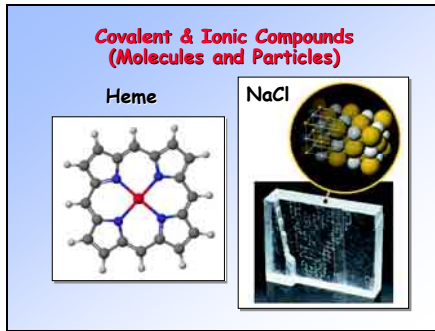
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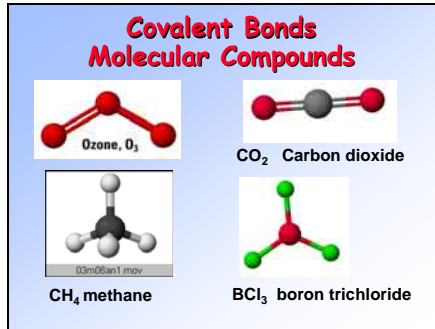
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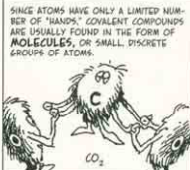


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COVALENT BOND (FORM MOLECULES)

When the attraction between atoms involves the **SHARING OF ELECTRONS**, we call this **COVALENT BONDING**.

These bonds involve **NONMETALS**

<p>COVALENT BONDING INVOLVES ELECTRON SHARING BETWEEN A SPECIFIC PAIR OF ATOMS. IT'S LIKE A HANDSHAKE.</p>  <p>ONLY YODOU...</p>	<p>SINCE ATOMS HAVE ONLY A LIMITED NUMBER OF "HANDS," COVALENT COMPOUNDS ARE USUALLY FOUND IN THE FORM OF MOLECULES, OR SMALL DISCRETE GROUPS OF ATOMS.</p>  <p>CO₂</p>
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To Illustrate An IONIC COMPOUND

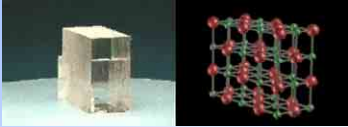
Reaction of aluminum and bromine



04m62vd1.mov

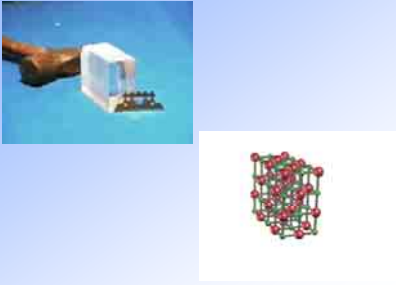
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**Ionic Bonds are held together by
ELECTROSTATIC FORCES**



The oppositely charged ions in ionic compounds are attracted to one another by **ELECTROSTATIC FORCES**. These forces are governed by **COULOMB'S LAW**.

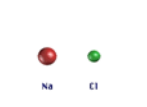

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**Properties of Ionic Compounds
(Particles)
Forming NaCl from Na and Cl₂**

- A metal atom can transfer an electron to a nonmetal.
- The resulting cation and anion are attracted to each other by **electrostatic forces**.




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IONIC COMPOUNDS FORMED FROM IONS

CATION + ANION ---> COMPOUND

$\text{Na}^+ + \text{Cl}^- \rightarrow \text{NaCl}$

A neutral compd. requires equal number of + and - charges.



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IONS AND IONIC COMPOUNDS (PARTICLES)

- **IONS** are atoms or groups of atoms with a positive or negative charge.
- **Taking away** an electron from an atom gives a **CATION** with a **positive charge**
- **Adding** an electron to an atom gives an **ANION** with a **negative charge**.


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Forming Cations & Anions

A CATION forms when an atom loses one or more electrons.

An ANION forms when an atom gains one or more electrons.


Cation



Mg 12 protons, 12 electrons, 03m07an1.mov

$\text{Mg} \rightarrow \text{Mg}^{2+} + 2\text{e}^-$

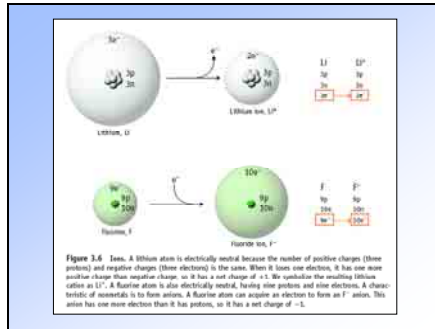
Anion



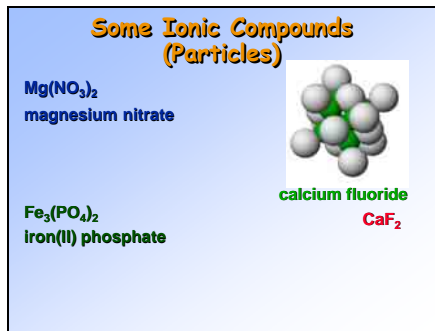
F 9 protons, 9 electrons, 03m07an2.mov

$\text{F} + \text{e}^- \rightarrow \text{F}^-$

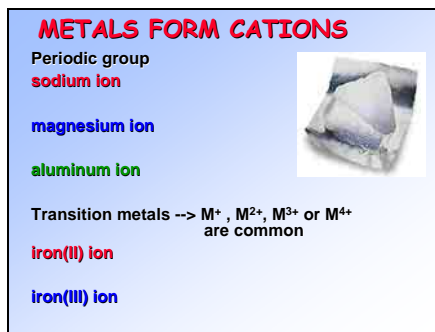
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NONMETALS FORMS ANIONS

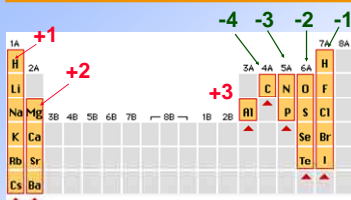
NONMETAL + n e⁻ -----> Xⁿ⁻
where n = 8 - Group no.



Group 4A	Group 5A	Group 6A	Group 7A
C ⁴⁻ , carbide	N ³⁻ , nitride	O ²⁻ , oxide	F ⁻ , fluoride
		S ²⁻ , sulfide	Cl ⁻ , chloride
			Br ⁻ , bromide
			I ⁻ , iodide

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Charges on Common Ions



By losing or gaining e⁻, atom has same number of e⁻'s as nearest Group 8A atom.

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Predicting Charges on Monatomic Ions

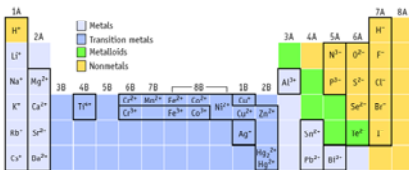
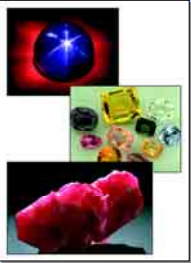


Figure 2.7 Charges on some common monatomic cations and anions. Metals usually form cations and nonmetals usually form anions.

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Gems & Minerals




- **Sapphire:** Al_2O_3 with Fe^{3+} or Ti^{3+} impurity gives blue whereas V^{3+} gives violet.
- **Ruby:** Al_2O_3 with Cr^{3+} impurity

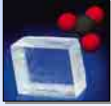
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POLYATOMIC IONS


Groups of atoms with a charge.

CO_3^{2-}
carbonate ion

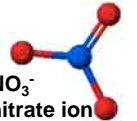




HNO_3
nitric acid



NO_3^-
nitrate ion

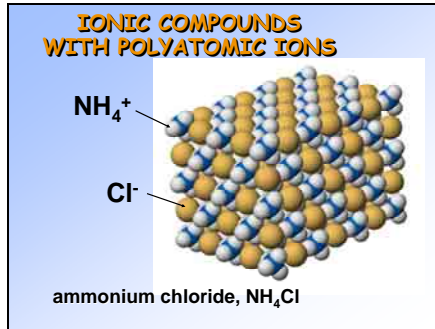


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Table 3.1 • Formulas and Names of Some Common Polyatomic Ions

Formula	Name	Formula	Name
CATIONS: Positive Ions			
NH_4^+	ammonium ion		
ANIONS: Negative Ions			
<i>Based on a Group 4A element</i>		<i>Based on a Group 7A element</i>	
CN^-	cyanide ion	ClO^-	hypochlorite ion
$\text{C}_2\text{O}_4^{2-}$	oxalate ion	ClO_2^-	chlorite ion
CO_3^{2-}	carbonate ion	ClO_3^-	chlorate ion
HCO_3^-	hydrogen carbonate ion (or bicarbonate ion)	ClO_4^-	perchlorate ion
<i>Based on a Group 5A element</i>		<i>Based on a transition metal</i>	
NO_2^-	nitrite ion	CrO_4^{2-}	chromate ion
NO_3^-	nitrate ion	$\text{Cr}_2\text{O}_7^{2-}$	dichromate ion
PO_4^{3-}	phosphate ion	MnO_4^-	permanganate ion
HPO_4^{2-}	hydrogen phosphate ion		
H_2PO_4^-	dihydrogen phosphate ion		
<i>Based on a Group 6A element</i>			
SO_4^{2-}	sulfate ion		
HSO_4^-	hydrogen sulfate ion (or bisulfate ion)		

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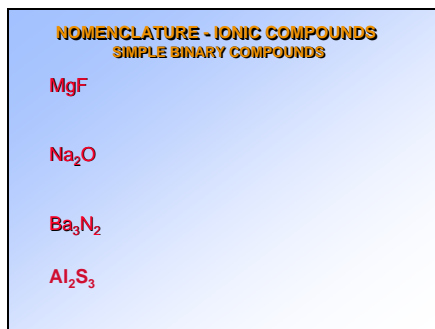
**NOMENCLATURE
Common Names**

NOMENCLATURE is a way of naming compounds (both ionic and covalent). There are two types of nomenclature, **COMMON NAME** and **SYSTEMATIC NAME**.

- **COMMON NAMES** are names that have been adapted through time, with no system to the way it is pronounced.
- NaHCO_3 - *Baking Soda*
- H_2O - *Water*
- $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ - *Sugar*
- NH_3 - *Ammonia*



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NOMENCLATURE - IONIC COMPOUNDS
COMPLEX BINARY COMPOUNDS

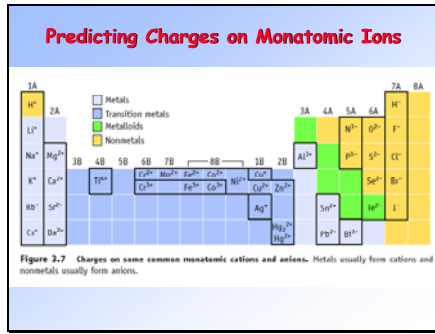
Fe₂O₃

PbCl₄

MnO

Cu₂S

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NOMENCLATURE - IONIC COMPOUNDS
WITH POLYATOMIC IONS

Na₂CO₃

CuSO₄

Fe₃(PO₄)₂

Al(HCO₃)₃


NH₄NO₃

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Table 3.1 Formulas and Names of Some Common Polyatomic Ions			
Formula	Name	Formula	Name
CATION: Positive Ion			
NH_4^+	ammonium ion		
ANIONS: Negative Ions			
Based on a Group 4A element		Based on a Group 7A element	
CN ⁻	cyanide ion	ClO ⁻	hypochlorite ion
$\text{C}_2\text{O}_4^{2-}$	oxalate ion	ClO ₂ ⁻	chlorite ion
CO_3^{2-}	carbonate ion	ClO ₃ ⁻	chlorate ion
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Based on a Group 5A element		Based on a transition metal	
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NO_3^-	nitrate ion	$\text{Cr}_2\text{O}_7^{2-}$	dichromate ion
PO_4^{3-}	phosphate ion	MnO_4^-	permanganate ion
HPO_4^{2-}	hydrogen phosphate ion		
H_2PO_4^-	dihydrogen phosphate ion		
Based on a Group 6A element			
OH ⁻	hydroxide ion		
SO_4^{2-}	sulfate ion		
SO_3^{2-}	sulfite ion		
HSO_4^-	hydrogen sulfate ion (or bisulfate ion)		


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Let us write the chemical formula for Potassium Chromate



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Lets us write the chemical formula for Chromium(III) Oxide



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Lets us write the chemical formula for Copper(II) Sulfate



The image shows two petri dishes on a light-colored surface. The dish on the left contains a bright blue powder, while the dish on the right contains a white powder. This likely represents the color change of copper(II) sulfate pentahydrate when it is heated to form anhydrous copper(II) sulfate.

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Writing Formulas - Ionic Compounds

strontium chloride

nickel borate

iron (III) hydroxide

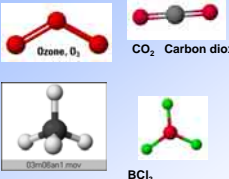
tin (IV) sulfate



A small cartoon character of a person with a backpack is located in the bottom right corner of the slide.

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Naming Molecular Compounds



The slide displays four ball-and-stick molecular models. Top left: Ozone (O₃) with three red spheres. Top right: Carbon dioxide (CO₂) with one black sphere and two red spheres. Bottom left: Methane (CH₄) with one black sphere and four white spheres. Bottom right: Boron trichloride (BCl₃) with one black sphere and three green spheres.

Ozone, O₃

CO₂ Carbon dioxide

CH₄ methane

BCl₃ boron trichloride

All are formed from two or more nonmetals.

Ionic compounds generally involve a metal and nonmetal (NaCl)

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**NOMENCLATURE
COVALENT COMPOUNDS (MOLECULES)**

MOLECULES are the combination of two or more nonmetals.

THERE IS NOT CHARGE TO LOOK AT WHEN NAMING MOLECULES!

- You name the first element using the exact element name.
- Name the second element by writing the stem name of the element with the suffix "-ide."
- If there is more than one atom of any given element, you add a prefix.

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

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NOMENCLATURE - COVALENT COMPOUNDS

SF_4

ClO_2

SF_6

Cl_2O_7

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**NOMENCLATURE
OXOACID MOLECULES**

An **oxoacid** is an acid containing hydrogen, oxygen, and another element.

Acid	Contains	Name
HNO_3	nitrate anion	nitric acid
	ate	to ic
HNO_2	nitrite anion	nitrous acid
	ite	to ous


Acids are traditionally defined as compounds with a potential H^+ as the cation.

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**NOMENCLATURE
NONOXOACID MOLECULES**

An **nonoxoacid** is an acid containing hydrogen, oxygen, and another element.

$\text{HCl}(g)$



$\text{HCl}(aq)$

hydrogen chloride

↓

hydrochloric acid

Nonoxoacids are not derived from a polyatomic ion.
They also contain the prefix: **hydro-**


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**NOMENCLATURE
HYDRATES**

A **hydrate** is an ionic compound that contains water molecules weakly bound in its crystals.

Example:
 Fe_2O_3 is a hematite mineral (compound for rust) which has a rhombohedral crystal (a hexagonal) system. When it combines with water it can form the hydrate: $\text{Fe}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$

Prefixes: mono, di, tri, tetra, hexa, hepta, nona, deca



$\text{Fe}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$
iron (III) oxide trihydrate

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