CHEMICAL NAMES & FORMULAS
SIGNIFICANCE OF A CHEMICAL FORMULA

Chemical formulas are important because they indicate the relative number of atoms of each kind of a chemical compound.

- **For an ionic compound**: chemical formulas represent one *formula unit*
  - *Formula unit*: the simplest ratio of the compound’s positive and negative ions

- **For a molecule**: the molecular formula gives the number of atoms of each element contained in a single molecule of the compound.
Monatomic ions: ions formed from a single atom
- Ex: Na⁺, Mg²⁺, S²⁻

Naming monatomic ions:
- Cations (+):
  - Name of element + cation
  - Ex: K⁺, Potassium cation
  - Mg²⁺, Magnesium cation
  - Al³⁺, Aluminum cation

- Anions (-):
  - Base of element + -ide
  - Ex: F⁻, Fluoride
  - N³⁻, Nitride
  - Br⁻, Bromide
**Predicting Ionic Charges**

**Oxidation numbers**: the ions charges that atoms gain when they lose or gain their valence electrons; are the number of electrons they can lose or gain when bonding.
### Predicting Ionic Charges

#### Group 1

Lose 1 electron to form **1+**

<table>
<thead>
<tr>
<th>Element</th>
<th>Atomic Number</th>
<th>Period</th>
<th>Ion Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen</td>
<td>1</td>
<td>1</td>
<td>1+</td>
</tr>
<tr>
<td>Lithium</td>
<td>3</td>
<td>2</td>
<td>1+</td>
</tr>
<tr>
<td>Beryllium</td>
<td>4</td>
<td>2</td>
<td>2+</td>
</tr>
<tr>
<td>Sodium</td>
<td>11</td>
<td>4</td>
<td>1+</td>
</tr>
<tr>
<td>Magnesium</td>
<td>12</td>
<td>4</td>
<td>2+</td>
</tr>
</tbody>
</table>

Note: The table snippet shows elements from the periodic table, highlighting the trend of Group 1 elements losing 1 electron to form a **1+** ion.
Group 2
Lose 2 electrons to form $\text{2}^+$. 
Group 13
Lose 3 electrons to form $3^+$
Group 14 rarely forms ions :/
Group 15
Gain 3 electrons to form $3^-$
Group 16
Gain 2 electrons to form 2-
Group 17
Gain 1 electrons to form $1^{-}$
Groups 3-12 (Transition Metals) d-block elements form **variable charges**

**Ex:**
- Copper can be $\text{Cu}^+ \text{ or } \text{Cu}^{2+}$
- Iron can be $\text{Fe}^{2+} \text{ or } \text{Fe}^{3+}$
Binary compounds: compounds composed of two different elements

For ionic compounds…
- The total # of positive charges and negative charges must be equal
**WRITING IONIC COMPOUND FORMULAS**

**Rules for writing formulas for ionic compounds:**

1. Write the symbols & charges for the ions (cations first)
2. Cross over the charges as subscripts
3. Check to make sure the charges are equal

**Ex: Aluminum Oxide**

1. Write the symbols for the ions (cations first)
   
   $\text{Al}^{3+} \quad \text{O}^{2-}$

2. Cross over the charges as subscripts
   
   $\text{Al}_2\text{O}_3$

3. Check to make sure the charges are equal
   
   $2 \times (+3) = +6 \quad 3 \times (-2) = -6$
YOU TRY!

• Write the formulas for the binary ionic compounds formed between the following elements:
  ○ Potassium and iodine
    - KI
  ○ Magnesium and chlorine
    - MgCl₂
  ○ Sodium and sulfur
    - Na₂S
NAMING BINARY IONIC COMPOUNDS

- Involves combining the names of cations and anions
- **Rules for naming ionic compounds:**
  1. Name the cation first: full name of cation
  2. Name anion last: base of anion + -ide

  **Ex:** $\text{Al}_2\text{O}_3$
  - $\text{Al} = \text{aluminum}$
  - $\text{O} = \text{oxygen} \rightarrow \text{oxide}$
  - $\text{Aluminum oxide}$
YOU TRY!

- Name the binary ionic compounds indicated by the following formulas:
  - AgCl
    - Silver chloride
  - ZnO
    - Zinc oxide
  - CaBr$_2$
    - Calcium bromide
Some elements (transition metals) form two or more cations with different charges.

Use the Stock System of nomenclature for compounds with transitional metals.

- Roman numerals represent charges in parentheses:
  - $\text{Fe}^{2+}$, Iron(II)
  - $\text{Fe}^{3+}$, Iron(III)

**Example:** $\text{CuCl}_2$  
*Hint*: undo the crisscross to determine cation charge!

- Copper(II) chloride
YOU TRY!

- Give the names for the following ionic compounds:
  - $\text{CuBr}_2$
    - Copper(II) bromide
  - $\text{PbCl}_2$
    - Lead(II) chloride
  - $\text{Fe}_2\text{O}_3$
    - Iron(III) oxide
Polyatomic ions are mostly anions (except $\text{NH}_4^+$)

- Most are oxyanions
  - **Oxyanion**: polyatomic ions that contain oxygen
- Most common anions have –ate endings
  (Ex: $\text{ClO}_3^-$ chlorate)
• Treat polyatomic ions as one unit!
  o Use parentheses if more than one polyatomic ion is present
    ▷ \textit{Ex}: \( \text{Al}_2(\text{SO}_4)_3 \)
• Rules for naming compounds with polyatomic ions:
  o Same as naming for regular ionic compounds except:
    ▷ Name polyatomic ion as one unit
      ○ \textit{Ex}: \( \text{AgNO}_3 \) = silver \textit{nitrate}
YOU TRY!

- Name the following binary compounds:
  - Na$_2$CO$_3$
    - Sodium carbonate
  - Ag$_3$PO$_4$
    - Silver phosphate
  - Fe(NO$_3$)$_3$
    - Iron(III) nitrate
Sample for writing formulas for compounds with polyatomic ions:

- **Ex:** Aluminum hydroxide
  \[ \text{Al}^{3+} + (\text{OH})^- \quad \text{Use crisscross method!} \]
  \[ \text{Al(OH)}_3 \]

**You Try!**

- Give the formula for the following ionic compounds:
  - Barium hydroxide
    - \[ \text{Ba(OH)}_2 \]
  - Copper(II) nitrate
    - \[ \text{Cu(NO}_3\text{)}_2 \]
Binary Molecular Compounds

- Prefixes used to note how many atoms in a compound:
  1. mono-
  2. di-
  3. tri-
  4. tetra-
  5. penta-
  6. hexa-
  7. hepta-
  8. octa-
  9. nona-
  10. deca-

- Rules for naming molecular compounds:
  1. Less-electronegative element is given first.
  2. First element only gets a prefix if it has more than one.
  3. Second element is named by combining:
     - A prefix indicating the number of atoms
     - The root name of the second element
     - The ending -ide
  4. The o or a at the end of a prefix is usually dropped when the word following the prefix begins with another vowel.
<table>
<thead>
<tr>
<th>Formula</th>
<th>Prefix-System Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{N}_2\text{O}$</td>
<td>Dinitrogen monoxide</td>
</tr>
<tr>
<td>$\text{NO}$</td>
<td>Nitrogen monoxide</td>
</tr>
<tr>
<td>$\text{NO}_2$</td>
<td>Nitrogen dioxide</td>
</tr>
<tr>
<td>$\text{N}_2\text{O}_3$</td>
<td>Dinitrogen trioxide</td>
</tr>
<tr>
<td>$\text{N}_2\text{O}_4$</td>
<td>Dinitrogen tetroxide</td>
</tr>
<tr>
<td>$\text{N}_2\text{O}_5$</td>
<td>Dinitrogen pentoxide</td>
</tr>
</tbody>
</table>
YOU TRY!

Name the following molecular compounds:
- $\text{SO}_3$
  - Sulfur trioxide
- $\text{ICl}_3$
  - Iodine trichloride
- $\text{PBr}_5$
  - Phosphorus pentabromide

Write the formulas for the following molecular compounds:
- Carbon tetraiodide
  - $\text{Cl}_4$
- Phosphorus trichloride
  - $\text{PCl}_3$
- Oxygen difluoride
  - $\text{OF}_2$