Unit Warm Up

1. What is the chemical name for salt? What is the chemical formula for salt?
2. What is a compound?
3. What are the two types of compounds?
4. How can you tell the difference between them?
5. Using your PT, predict the charge of the following atoms when they are part of an ionic compound: Na, K, Ca, O, F, Cl.
Introduction

Nomenclature

Writing formulas for compounds from names and writing names for compounds from formulas

Rules set by IUPAC(International Union of Pure and Applied Chemistry)
We will concern ourselves with any compound that is not considered organic (long chains of carbon atoms)

Based on the type of compound

Binary – only two elements in compound
   \( \text{NaCl, CH}_4 \)

Nonbinary (Complex) – three or more elements in compound
   \( \text{H}_2\text{SO}_4, (\text{NH}_4)_3\text{PO}_4 \)
Section 1: Naming Binary Compounds

Three types of binary compounds

Types I & II – Ionic

contain ions – a cation and an anion

contain a metal and a nonmetal
Cation

Metal

$1^{st}$ symbol in formula

Anion

Nonmetal

$2^{nd}$ symbol in formula
Type III – Covalent (Molecular)
Contain nonmetals only
No ions
Binary Ionic Type I Compounds
Cation has only 1 possible charge
(Check PT)

Naming
Name the cation, then name the anion
Example

MgCl$_2$

Binary – 2 different elements (2 capital letters)

Ionic – Mg is a metal (Check PT)

Type I – Mg has only 1 possible charge (check PT)
Mg$^{2+}$ is the cation
magnesium
Cl$^{1-}$ is the anion
Chloride
NAME THE CATION, THEN THE ANION
Name is magnesium chloride
Practice

1. Name the following compounds
   a. KCl
      potassium chloride
   b. Rb₃N
      rubidium nitride
   c. Ba₃P₂
      barium phosphide
d. Li₂O
   lithium oxide

e. CaI₂
   calcium iodide
Binary Ionic Type II Compounds
Cation has more than one possible charge
(Check PT)
Name the cation, then name the anion
Naming the cation

Determining the charge on the cation

Compounds are electrically neutral

Total positive charge = total negative charge

Anions can only have 1 possible charge
How to determine the charge on the cation:

1. Multiply the charge on the anion (check the PT) by the subscript for the anion to get the total negative charge

   \[ \text{total negative charge} = (\text{charge on anion})(\text{subscript on anion}) \]

2. Change the sign to positive to get the total positive charge.

   \[ \text{Total positive charge} = (+)(\text{total negative charge}) \]

3. Divide that answer by the subscript on the cation. That number is the charge on the cation.

   \[ \text{Charge on cation} = (\text{total positive charge})/(\text{subscript on cation}) \]
4. Write this number as a Roman Numeral in parenthesis after the name for the element.

5. Name the cation, then name the anion
Examples

FeCl$_2$

Binary – only two elements (2 capital letters)

Ionic – contains a metal (Fe) and a nonmetal

Type II – Fe(iron) can be +2 or +3

Cl$^-$ (chloride) is the anion
Determine charge on cation

1. Charge on anion is -1, subscript is 2
   \[2 \times -1 = -2 = \text{total negative charge}\]

2. Total positive charge = +2

3. Subscript on cation is 1; charge on cation is \( \frac{2}{1} = 2 \)

3. Charge on Fe is +2

4. iron (II) chloride
\( \text{Ni}_2\text{O}_3 \)

Binary – only two elements (two capital letters)

Ionic – contains a metal (Ni) and a nonmetal

Type II – Ni(nickel) can be +2 or +3
Determine charge on the cation

1. Charge on anion is -2, subscript is 3
   \[3 \times -2 = -6 = \text{total negative charge}\]
2. Total positive charge is +6
3. Subscript on cation is 2; charge on cation is \[\frac{6}{2} = +3\]
4. nickel (III) oxide
Practice

Name the following compounds. Show your work.

a. FeBr$_3$
   iron(III) bromide

b. FeBr$_2$
   iron(II) bromide

c. Ti$_2$O$_3$
   titanium(III) oxide
d. TiO$_2$
   titanium(IV) oxide

e. Cr$_3$N$_2$
   chromium(II) nitride

f. CrN
   chromium(III) nitride
Binary Covalent (Molecular) Compounds

Compound contains 2 nonmetals
No ions
The two nonmetals may form more than one different compound
Use prefixes in name to indicate number of each type of atom

1 = mono
2 = di
3 = tri
4 = tetra
5 = penta
6 = hexa
7 = hepta
8 = octa
9 = nona
10 = deca
Naming Covalent Compounds

Write the name of the 1st element adding a prefix if the subscript is not 1

Write the name of the second element adding a prefix for the subscript, even if the subscript is 1, and changing the ending to –ide

When adding prefixes, omit the ending vowel on the prefix, if it is an o or a, and would make a double vowel
Examples

CO

Binary – contains only 2 elements
Covalent – both elements are nonmetals
C (carbon) is the first element, subscript 1, no prefix
O (oxygen) is the second element, subscript 1, prefix is mono
carbon monoxide (no double o)
P₂O₅

Binary – contains only 2 elements
Covalent – both elements are nonmetals
P (phosphorus) is the first element, subscript 2, prefix is di
O (oxygen) is the second element, subscript 5, prefix is penta
diphosphorus pentoxide (no ao combination)
Practice

1. Name the following compounds.
   a. CO$_2$  
      carbon dioxide
   b. PBr$_5$  
      phosphorus pentabromide
   c. N$_2$O$_3$  
      dinitrogen trioxide
d. $\text{SO}_3$
   sulfur trioxide

e. $\text{P}_4\text{O}_6$
   tetraphosphorus hexoxide
Section 2: Naming Nonbinary Compounds

Nonbinary Ionic compounds

Compounds containing a polyatomic ion. Usually start with a metal – exception is \( \text{NH}_4^+ \) -- the ammonium cation

**Name the cation, then the anion**
Treat as a Type I or Type II compound
The ending on the polyatomic ion does not change
Notice most end in –ite or –ate
Means the polyatomic ion contains oxygen (oxyions)
-ate contains more oxygen atoms than –ite
Exception is –OH$^{1-}$ – called hydroxide
Examples

Na$_2$SO$_4$

- Nonbinary – contains more than 2 elements
- Ionic – contains a metal &/or a polyatomic
- Type I – Na has only 1 possible charge
  
  Na$^{1+}$ (sodium) is the cation
  SO$_4^{2-}$ (sulfate) is the anion
  
  sodium sulfate
$\text{Co (HCO}_3\text{)}_3$

Nonbinary – contains more than 2 elements

Ionic – contains a metal &/or a polyatomic

Type II  -- Co has more than 1 possible charge

Total negative charge = $-1 \times 3 = -3$

Total positive charge = $+3$

Charge on cation = $3/1 = 3$

cobalt (III) bicarbonate
**NH₄NO₃**

- **Nonbinary** – contains more than 2 elements
- **Ionic** – contains a metal &/or a polyatomic
- **Type I** – NH₄⁺ has only 1 possible charge
  - NH₄⁺ (ammonium) is the cation
  - NO₃⁻ (nitrate) is the anion

ammonium nitrate
Practice

Give the type and name the following compounds. Show your work.

a. $\text{Na}_2\text{CO}_3$
   sodium carbonate

b. $\text{CuSO}_4$
   copper(II) sulfate

c. $\text{CsClO}_4$
   cesium perchlorate
d. \( \text{Co(NO}_3\text{)}_3 \)
   cobalt(III) nitrate

e. \( \text{Au}_2(\text{SO}_3\text{)}_3 \)
   gold(III) sulfite
Section 3: Acids

A compound that produces $\text{H}^+$ ions when dissolved in water

Ionic compounds

Cation is the $\text{H}^{1+}$ ion – hydrogen acting as a metal
Formulas begin with H
Have subscript (aq) at end
Aq = aqueous = dissolved in water
Two Types

Binary Acids

Oxyacids
Binary Acids
Cation is $H^{1+}$
Anion does not contain oxygen
Examples
$HCl_{(aq)}$, $HCN_{(aq)}$, $HBr_{(aq)}$
$=_{(aq)}$ aqueous -- means dissolved in water
Naming

the $\text{H}^{1+}$ ion is named hydro-
the ending of the anion is changed to –ic
the word acid is added at the end
Binary Acid Anions

F$^{1-}$ fluoric
Cl$^{1-}$ chloric
Br$^{1-}$ bromic
I$^{1-}$ iodic
At$^{1-}$ astatic
CN$^{1-}$ cyanic
S$^{2-}$ sulfuric
Se$^{2-}$ selenic
Te$^{2-}$ telluric
P$^{3-}$ phosphoric
As$^{3-}$ arsenic
Example

\[ \text{HCl}_{(aq)} \]

Acid – starts with H, is aqueous

Binary – anion does not contain oxygen

\( \text{H}^{1+} \) is cation (hydro-)

\( \text{Cl}^{1-} \) is anion (chloride – change ending to -ic)

hydrochloric acid

If not dissolved in water, name as an ionic compound (HCl would be hydrogen chloride)
Practice

1. Name the following compounds
   a. $\text{HI}_{(aq)}$
      hydroiodic acid
   b. $\text{H}_2\text{S}_{(aq)}$
      hydrosulfuric acid
   c. $\text{HF}_{(aq)}$
      hydrofluoric acid
Oxyacids

Cation is still H⁺

Anion is a polyatomic ion that contains oxygen

Exceptions – hydroxide (OH⁻¹) and peroxide (O₂²⁻) do not make acids.

Examples

HNO₃(aq), H₂SO₃(aq)
Naming

Name the anion, changing the ending to -ous if it was –ite or -ic if it was –ate

Add the word acid at the end
Examples

$\text{H}_2\text{SO}_4(\text{aq})$

Acid – starts with H, is aqueous

Oxyacid – anion contains oxygen

Anion is $\text{SO}_4^{2-}$ (sulfate)

Changes to sulfuric

sulfuric acid
H$_2$SO$_3$(aq)

Acid – starts with H, is aqueous
Oxyacid – anion contains oxygen
Anion is $\text{SO}_3^{2-}$ (sulfite)
Changes to sulfurous
sulfurous acid
Practice

1. Name the following compounds.
   a. $\text{HNO}_3(\text{aq})$
      nitric acid
   b. $\text{H}_2\text{CO}_3(\text{aq})$
      carbonic acid
c. $\text{HClO}_{(aq)}$
   hypochlorous acid

  d. $\text{H}_3\text{AsO}_4_{(aq)}$
   arsenic acid
Section 4: Writing Formulas from Names

Ionic compounds (review)
  Write down the symbol and the charge of the cation
  Write down the symbol and the charge of the anion
  Do the “X” thing – don’t forget parenthesis if more than 1 polyatomic ion
  Simplify if needed
Examples
magnesium chloride
Cation is $\text{Mg}^{2+}$
Anion is $\text{Cl}^{-}$
$\text{Mg}^{2+} \text{Cl}^{-}$
$\text{MgCl}_2$
nickel(III) carbonate

Cation is $\text{Ni}^{3+}$

Anion is $\text{CO}_3^{2-}$

$\text{Ni}^{3+} \equiv \text{CO}_3^{2-}$

$\text{Ni}_2(\text{CO}_3)_3$
lead(IV) oxalate
cation is $\text{Pb}^{4+}$
anion is $\text{C}_2\text{O}_4^{2-}$

$$\text{Pb}^{4+} \text{C}_2\text{O}_4^{2-}$$

$\text{Pb}_2(\text{C}_2\text{O}_4)_4$

Simplify: $\text{Pb}(\text{C}_2\text{O}_4)_2$
Practice
1. Write the formula for each of the following compounds
   a. barium hydroxide
      \[ \text{Ba(OH)}_2 \]
   b. cobalt(III) sulfate
      \[ \text{Co}_2(\text{SO}_4)_3 \]
c. lithium chloride
LiCl

d. chromium(II) chromate
CrCrO₄
Covalent Compounds

Write down the symbol for the first element and use the prefix to determine the subscript – remember no “1” subscripts

Write down the symbol for the second element and use the prefix to determine the subscript – remember no “1” subscripts

DO NOT SIMPLIFY
Examples

carbon dioxide

Binary – only 2 elements
Covalent -- two nonmetals
1st element is C(carbon) no prefix – so no subscript
2nd element is O(oxygen) prefix di so subscript is 2
Formula is CO$_2$
dinitrogen tetroxide

Binary – only 2 elements
Covalent -- two nonmetals

1\textsuperscript{st} element is N(nitrogen), prefix is di so subscript is 2
2\textsuperscript{nd} element is O(oxygen), prefix is tetra so subscript is 4

Formula is N\textsubscript{2}O\textsubscript{4} -- do not simplify
Practice

1. Write the formula for each of the following compounds

a. nitrogen monoxide
   \( \text{NO} \)

b. diphosphorus pentoxide
   \( \text{P}_2\text{O}_5 \)

c. carbon disulfide
   \( \text{CS}_2 \)
Acids

Identify the type of acid
Write down $\text{H}^{1+}$ for the cation
Write down the symbol and charge for the anion (watch endings)
  - binary –ic to –ide
  - oxyacid -ic to -ate; -ous to -ite
Do the “X” thing
Add the subscript (aq) at the end
Examples

nitric acid

oxyacid

Cation is $H^{+1}$

Anion is nitrate(-ic to –ate) $NO_3^{-1}$

$H^{+1} \cdot NO_3^{-1} \rightarrow HNO_3(aq)$
hydrobromic acid
binary acid
Cation is H$^{+1}$
Anion is bromide (-ic to –ide)Br$^{-1}$

\[ \text{H}^{+1} \text{ Br}^{-1} \rightarrow \text{HBr}_\text{(aq)} \]
Sulfurous acid

oxyacid

Cation is $H^+\,^1$

Anion is sulfite (-ous to –ite) $SO_3^{2-}$

$H^+\,^1\quad SO_3^{2-}\quad \longrightarrow\quad H_2SO_3(aq)$
Practice
1. Write the formula for each of the following compounds
   a. phosphoric acid
      \( \text{H}_3\text{PO}_4(\text{aq}) \)
   b. hydroiodic acid
      \( \text{HI}(\text{aq}) \)
c. bromic acid
   \[ \text{HBrO}_3(\text{aq}) \]
d. hydrophosphoric acid
   \[ \text{H}_3\text{P}(\text{aq}) \]