

Outline

- Elements and Compounds
- Naming Ionic Compounds
- Naming Molecular Compounds

Elements and Compounds

Elements are either atomic or molecular...

atomic elements exist as single atoms: noble gases and metals

molecular elements exist as two or more atoms:

elements as diatomics: H_2 , N_2 , O_2 , F_2 , Cl_2 , Br_2 , I_2

elements as polyatomics: P_4 and S_8

Elements combine in a definite proportion (by mass) to form compounds...

law of constant proportion

suggests that atoms combine in whole-number ratios

Compounds are represented with chemical formulas

elements represented with symbols

subscript determines number of atoms

group of atoms contained in parentheses

Consider...

H_2S 2 H's, 1 S

Cl_2 2 Cl's

ZnNO_3 1 Zn, 1 N, 3 O's

$\text{Pb}(\text{NO}_3)_2$ 1 Pb, 2 N's, 6 O's

$(\text{NH}_4)_2\text{SO}_4$ 2 N's, 8 H's, 1 S, 4 O's

Compounds are either molecular or ionic...

molecular compounds form between nonmetal atoms...

the atoms are uncharged

the basic unit is a molecule

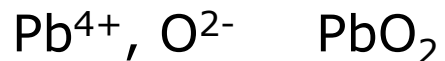
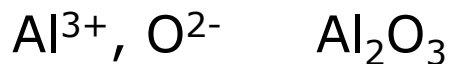
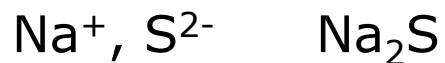
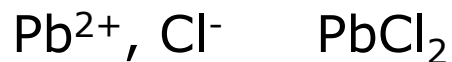
ionic compounds form between metal and nonmetal atoms...

then atoms are charged

the basic unit is a formula unit

Ions combine with one another according to the principle of electrical neutrality

Total charge of the cations should equal total charge of the anions



Formula mass is the sum of the atomic masses of all atoms present in one formula unit

$$\text{NaCl} \quad 22.99 \text{ amu} + 35.45 \text{ amu} = \underline{58.44 \text{ amu}}$$

$$\text{CO}_2 \quad 12.01 \text{ amu} + 2(16.00 \text{ amu}) = \underline{44.01 \text{ amu}}$$

$$\text{KF} \quad 39.10 \text{ amu} + 19.00 \text{ amu} = \underline{58.10 \text{ amu}}$$

$$\text{PbCl}_2 \quad 207.2 \text{ amu} + 2(35.45 \text{ amu}) = \underline{278.1 \text{ amu}}$$

$$\begin{aligned} \text{Mg(NO}_3)_2 \quad & 24.31 \text{ amu} + 2(14.01 \text{ amu}) + 6(16.00 \text{ amu}) \\ & = \underline{148.33 \text{ amu}} \end{aligned}$$

Type I Compounds... metals that form only one cation:

Group 1 (1+), Group 2 (2+), Al^{3+} , Zn^{2+} , Ag^{+}

Cations named as elemental name

| | | |
|-------------------------|------------------------------------|--------------------|
| KCl | K^{+} , Cl^{-} | potassium chloride |
| LiH | Li^{+} , H^{-} | lithium hydride |
| Al_2O_3 | Al^{3+} , O^{2-} | aluminum oxide |

The formulas are determined by charge balance...

| | | |
|-------------------|------------------------------------|-----------------------|
| zinc sulfide | Zn^{2+} , S^{2-} | ZnS |
| sodium oxide | Na^{+} , O^{2-} | Na_2O |
| magnesium bromide | Mg^{2+} , Br^{-} | MgBr_2 |

Type II Compounds... metals that form more than one cation:

All other metals...

Old system:

ion with higher charge has name ending in *-ic*, ion with lower charge has name ending in *-ous*

| | | | |
|--------------------------|---------------------------------|--------------------|----------|
| Fe^{2+} | ferrous | Fe^{3+} | ferric |
| Cu^{+} | cuprous | Cu^{2+} | cupric |
| Hg_2^{2+} | mercurous | Hg^{2+} | mercuric |
| Hg_2Cl_2 | $\text{Hg}_2^{2+}, \text{Cl}^-$ | mercurous chloride | |
| HgCl_2 | $\text{Hg}^{2+}, \text{Cl}^-$ | mercuric chloride | |

New system:

Cations named as elemental name followed by their charge as a roman numeral in parentheses

CuCl_2 Cu^{2+} , Cl^- copper(II) chloride

PbO_2 Pb^{4+} , O^{2-} lead(IV) oxide

NiS Ni^{2+} , S^{2-} nickel(II) sulfide

The formulas are determined by charge balance...

mercury(I) iodide Hg_2^{2+} , I^- Hg_2I_2

manganese(II) bromide Mn^{2+} , Br^- MnBr_2

chromium(III) oxide Cr^{3+} , O^{2-} Cr_2O_3

Ionic compounds may contain polyatomic ions...

Polyatomic ions containing oxygen are oxyanions

Polyatomic ions must be memorized

If an element makes 1 oxyanion, it ends in *-ate*

CO_3^{2-} carbonate

If an element makes 2 oxyanions, they end in *-ate* and *-ite*

| | | | |
|--------------------|-----------|--------------------|-----------|
| NO_3^- | nitrate | NO_2^- | nitrite |
| SO_4^{2-} | sulfate | SO_3^{2-} | sulfite |
| PO_4^{3-} | phosphate | PO_3^{3-} | phosphite |

If an element makes 4 oxyanions, the prefixes *hypo-* (less than) and *per-* (more than) are used in addition to *-ate* and *-ite*

ClO_4^- perchlorate

ClO_3^- chlorate

ClO_2^- chlorite

ClO^- hypochlorite

NaClO

sodium hypochlorite

K_2SO_4

potassium sulfate

barium hydroxide

$\text{Ba}^{2+}, \text{OH}^-$

$\text{Ba}(\text{OH})_2$

iron(III) nitrate

$\text{Fe}^{3+}, \text{NO}_3^-$

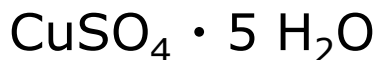
$\text{Fe}(\text{NO}_3)_3$

Hydrates

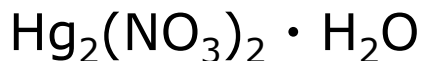
Compounds with water molecules trapped in their crystal

Compound is named, then a prefix for the number of waters, followed by *-hydrate*

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



copper(II) sulfate pentahydrate



mercury(I) nitrate monohydrate

Naming Molecular Compounds

Binary (2 atoms) compounds

First nonmetal: name element, use prefix if more than 1 atom

Second nonmetal: name ends in *-ide*, always use prefix

| | |
|------------------|----------------------|
| CO ₂ | carbon dioxide |
| CO | carbon monoxide |
| CCl ₄ | carbon tetrachloride |

| | |
|----------------------|-------------------|
| dinitrogen monoxide | N ₂ O |
| phosphorus triiodide | PI ₃ |
| bromine trichloride | BrCl ₃ |

Acids

Arrhenius acid: a compound that loses hydrogen ions in solution



Arrhenius base: a compound that loses hydroxide ions in solution



Acids are named as an ionic compound when out of water

HCl hydrogen chloride

HBr hydrogen bromide

HI hydrogen iodide

Acids are named as an "acid" when dissolved in water...

a) Anion in acid ends in *-ide*:

hydro – root – *ic* acid

b) Anion in acid ends in *-ate*:

root – *ic* acid

c) Anion in acid ends in *-ite*:

root – *ous* acid

| Compound... | Anion... | Acid in water... |
|--------------------------------|--------------|--------------------|
| HBr | bromide | hydrobromic acid |
| H ₂ S | sulfide | hydrosulfuric acid |
| HNO ₃ | nitrate | nitric acid |
| HNO ₂ | nitrite | nitrous acid |
| H ₂ SO ₄ | sulfate | sulfuric acid |
| HClO ₄ | perchlorate | perchloric acid |
| HClO | hypochlorite | hypochlorous acid |