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
$Pb(NO_3)_2$	1 Pb, 2 N's, 6 O's
$(NH_4)_2SO_4$	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

K^+, F^-	KF
Pb^{2+}, Cl^-	$PbCl_2$
Na^+, S^{2-}	Na_2S
Al^{3+}, O^{2-}	Al_2O_3
Pb^{4+}, O^{2-}	PbO_2

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

NaCl	22.99 amu + 35.45 amu = 58.44 amu
CO_2	12.01 amu + 2(16.00 amu) = 44.01 amu
KF	39.10 amu + 19.00 amu = 58.10 amu
$PbCl_2$	207.2 amu + 2(35.45 amu) = 278.1 amu
$Mg(NO_3)_2$	24.31 amu + 2(14.01 amu) + 6(16.00 amu)
	= 148.33 amu

Naming Ionic Compounds

Name cation first, anion second

Cation: monatomic metal ions retain their elemental names

H^+ hydrogen (ion)

Be^{2+} beryllium (ion)

Anion: monatomic nonmetal ions retain the root of their elemental name, ending in *–ide*

F^-	fluoride	H^-	hydride
O^{2-}	oxide	S^{2-}	sulfide
N^{3-}	nitride	P^{3-}	phosphide

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	Hg_2^{2+}, Cl^-	mercurous chloride
$HgCl_2$	Hg^{2+}, 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	Ba^{2+}, OH^-	$Ba(OH)_2$
iron(III) nitrate	Fe^{3+}, NO_3^-	$Fe(NO_3)_3$

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

$CuSO_4 \cdot 5\ H_2O$	copper(II) sulfate pentahydrate
$Hg_2(NO_3)_2 \cdot H_2O$	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_2O
phosphorus triiodide	PI_3
bromine trichloride	$BrCl_3$

Acids

Arrhenius acid: a compound that loses hydrogen ions in solution

$$HA \rightarrow H^+ + A^-$$

Arrhenius base: a compound that loses hydroxide ions in solution

$$BOH \rightarrow B^+ + OH^-$$

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_2S	sulfide	hydrosulfuric acid
HNO_3	nitrate	nitric acid
HNO_2	nitrite	nitrous acid
H_2SO_4	sulfate	sulfuric acid
$HClO_4$	perchlorate	perchloric acid
HClO	hypochlorite	hypochlorous acid