

Compounds (structure and naming)

Compounds

Ionic (made of ions)

Composed of a Metal (left side) and a Nonmetal (right side)

One element from the left side and one from the right side of the Periodic Table

NaCl or MgF₂

On the left side of Periodic Table they lose electrons (become +)

On the right side of Periodic Table they receive electrons (become -)

H is on left side but is nonmetal – sometimes acts like H⁺ and sometimes like H⁻

Covalent (made of molecules or networks of atoms)

Composed of a Nonmetal and a Nonmetal

Both come from right side of periodic table

NO₂ or HCl (H on left side but is a nonmetal)

Compounds can be decomposed into elements

Compounds are composed of two or more types of atoms

Molecules are collection of atoms that are building blocks of some compounds

The fantastic knowledge that comes from Chemistry is used

to both understand the world and for many practical applications

Chemical Formulas (some common examples given below)

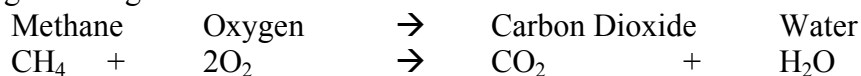
Chemical Formula	Name	Importance
O ₂	Oxygen gas	Necessary for animal life
CO	Carbon monoxide	Prevents you from getting O ₂ because CO binds to Fe in the Hemoglobin (in red blood cells)
CO ₂	Carbon dioxide	Necessary for plant life to produce sugars
CH ₄	Methane gas	Natural gas, burn for energy
H ₂ O	Water	need for living things
C ₆ H ₁₂ O ₆	Fructose	One type of sugar made by plants from CO ₂ and H ₂ O

$C_6H_{12}O_6$	Glucose (same formula different molecule)	Sugar commonly used for energy by human body
CH_3OH	Methanol	Type of alcohol that can cause blindness or death if ingested
C_2H_5OH	Ethanol	Type of alcohol found in all alcoholic beverages

American Chemical Society keeps track of all compounds assigns each a special number called registry number. Over 20 million known compounds are known.

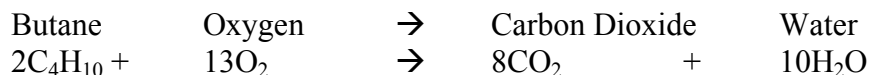
Chemical Reaction shown by balanced chemical equation

Burning natural gas:



The number preceding the compound is known as the coefficient

Lighter flame:



The equation is balanced if the number of atoms on left (reactants) and right (products) are the same

(Reactants)		(Products)	for butane lighter reaction	
8	C	8		
20	H	20		
36	O	36		

Matter and Changes

Chemistry is study of matter and changes matter can undergo

Change:

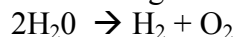
1) Physical Change – identity is the same but properties different

Ex: separate mixture – divide sugar and salt

Change state – ice \rightarrow water \rightarrow steam

Do NOT create new chemical species

2) Chemical Change – create new chemical species



Strike match – chemical change

Break a match – physical change

Dissolve table sugar – physical change
sucrose molecules($C_{12}H_{22}O_{11}$) spread out in water

Dissolve table salt – chemical change
 $NaCl \rightarrow Na^+ + Cl^-$ ions form and spread out in water

Matter:

Mixture (more than one substance mixed together)

- 1) Homogenous– same throughout ex: salt water is same throughout
- 2) Heterogeneous– not same everywhere ex: oil-water has two different layers

Pure Substance (same composition and proportion of elements)

- 1) Pure element such as Na Cl₂ H₂ O₂
- 2) Pure compound such as NaCl or H₂O or C₆H₁₂O₆

Matter and Change:

elements can be combined to make compound

compound can be decomposed to produce elements

compounds can be combined to produce new compounds

Naming Scheme

Ionic Compounds can be either cations (left) + or anions (right) –

Cations can be either

- monatomic with either a unique or variable charge
- polyatomic

Anions then can be either

- monatomic (ide ending)
- polyatomic with either (ide ending) or if with oxygen (ate, ite)

Covalent Compounds Nomenclature

(left) either monatomic or polyatomic

(right) either monatomic or polyatomic

Cation (+ ion)

Monatomic ion:

Unique charge

One type of cation refer to name of metal

Na^+ Sodium

Mg^{2+} Magnesium

Al^{3+} Aluminum

need to know that always Group IA (group 1) = +1 Group IIA (group 2) = +2 Al = +3

Variable Charge – More than one type of cation

Cation	Modern	Old
Cu^+	Copper (I)	Cuprous
Cu^{2+}	Copper (II)	Cupric
Fe^{2+}	Iron (II)	Ferrous
Fe^{3+}	Iron (III)	Ferric

Expected to know modern scheme and just be aware of old system.

Modern system uses Roman number to designate charge.

Older system uses latin names and ous = lower and ic = higher endings for higher and lower of two possible charges.

Polyatomic

Cation atoms held together by covalent bonds but have overall positive charge

NH_4^+ Ammonium

Hg_2^{2+} Mercury (I) Mercurous

H_3O^+ Hydronium

Anions

Monatomic

replace ending of nonmetal with ide

Cl^- Chloride

O^{2-} Oxide

N^{3-} Nitride

S^{2-} Sulfide

Know

VIIA (group 17) = -1 (can include H as sometimes acts like H)

VIA (group 16) = -2

VA (group 15) = -3

Polyatomic

CN⁻ Cyanide
OH⁻ Hydroxide
O₂²⁻ Peroxide

Other polyatomic with oxygen end with ate or ite

ClO₄⁻ Perchlorate
ClO₃⁻ Chlorate
ClO₂⁻ Chlorite
ClO⁻ Hypochlorite

NO₃⁻ Nitrate
NO₂⁻ Nitrite

Learn Common Polyatomic Ions in textbook

Naming Examples

Ammonium sulfide (NH₄)₂S
Iron (III) oxide Fe₂O₃
Iron (II) oxide FeO
Copper (II) cyanide Cu(CN)₂

* Use parenthesis if more than one polyatomic ion

THINK IONS

see this Al₂O₃ and think of the ions Al³⁺ O²⁻ name aluminum oxide
see this Na₂O and think of the ions Na⁺ O²⁻ name sodium oxide
see this Cu(NO₃)₂ and think of ions Cu²⁺ NO₃⁻ name copper(II) nitrate
see this copper(II) nitrate and think of ions Cu²⁺ CN⁻ and then write Cu(CN)₂
Name does not give combining ratio – have to determine from ion charges!

Naming with hydrogen

(H is nonmetal but often named as if H⁺ cation)

H₂S hydrogen sulfide
HCl hydrogen chloride
HBr hydrogen bromide
H₂O₂ hydrogen peroxide O₂²⁻ peroxide named like ionic)
PCl₅ phosphorus pentachloride
UF₆ uranium hexafluoride (some metal-nonmetals are more covalent than ionic)
HClO₄ hydrogen perchlorate (hydrogen like positive ion)
HClO₃ hydrogen chlorate
HClO₂ hydrogen chlorite

HClO hydrogen hypochlorite

HNO₃ hydrogen nitrate

HNO₂ hydrogen nitrite

H₂SO₄ hydrogen sulfate

H₂SO₃ hydrogen sulfite

H₃N hydrogen nitride

LiH lithium hydride (ionic: hydrogen like negative ion)

Binary Covalent Compounds Nomenclature

These are made of nonmetals

Systematic

Use Greek prefixes if more than one atom

1 – mono (omit for first element, omit for second if only one possibility)

2 – di

3 – tri

4 – tetra

5 – penta

6 – hexa

7 – hepta

8 – octa

9 – nona

10 – deca

Add ide ending on second element (name like ion)

O₂F₂ dioxygen difluoride

HCl hydrogen chloride

NO nitrogen monoxide (old name: nitric oxide)

N₂O dinitrogen monoxide (old name: nitrous oxide)

NO₂ nitrogen dioxide

N₂O₃ dinitrogen trioxide

N₂O₅ dinitrogen pentoxide (drop final o or a in prefix if element begins with vowel)

Trivial Names

H₂O water

NH₃ ammonia

N₂H₄ hydrazine

PH₃ phosphine

Acid Nomenclature

Naming Inorganic Acids

these names are used only if compound dissolved in water to make acid

Acid – releases H^+ ion (attaches to water to form H_3O^+ hydronium)

Acids without Oxygen

Binary or binary related acids hydro ___ ic acid

Ex:

	Compound Name	Acid Name
HCl	hydrogen chloride	hydrochloric acid
H ₂ S	hydrogen sulfide	hydrosulfuric acid
HCN	hydrogen cyanide	hydrocyanic acid

Acids WITH Oxygen

Tenary oxoacids

Compounds ending acid ending

ate -----> ic

ite -----> ous

Ex:

	Compound Name	Acid Name
HClO ₄	hydrogen perchlorate	perchloric acid
HClO ₃	hydrogen chlorate	chloric acid
HClO ₂	hydrogen chlorite	chlorous
HCl	hydrogen hypochlorite	hypochlorous
H ₂ SO ₄	hydrogen sulfate	sulfuric acid
H ₂ SO ₃	hydrogen sulfite	sulfurous acid
HNO ₃	hydrogen nitrate	nitric acid
HNO ₂	hydrogen nitrite	nitrous acid
HC ₂ H ₃ O ₂	hydrogen acetate	acetic acid
H ₂ CO ₃	hydrogen carbonate	carbonic acid
H ₃ BO ₃	hydrogen borate	boric acid
HIO ₂	hydrogen iodite	iodous acid

Naming review and everyday uses

Examples:

NaCl	sodium chloride (table salt, used in solutions for contact lens)
ZnO	zinc oxide (used in some sunscreens and diaper rash ointment)
NaF	sodium fluoride (active ingredient in toothpaste)
SeS	selenium sulfide (in selsium blue shampoo)
NaNO ₂	sodium nitrite (preservation in meat such as bacon)
NaClO	sodium hypochlorite (bleach)
N ₂ O	dinitrogen oxide (laughing gas used for some dental work)
NaHCO ₃	sodium bicarbonate (baking soda)

Look on boxes or bottles used around your home
and see if you recognize names of the inorganic ingredients.