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 MgF_2

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
NO_2 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_2O	Water	need for living things
$C_6H_{12}O_6$	Fructose	One type of sugar made by plants from CO_2 and H_2O

$C_6H_{12}O_6$	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.

<u>Chemical Reaction</u> shown by balanced chemical equation
Burning natural gas:

Methane		Oxygen		Carbon Dioxide		Water
CH_4	+	$2O_2$	→	CO_2	+	H_2O

The number preceding the compound is known as the coefficient

Lighter flame:

Butane	Oxygen		Carbon Dioxide		Water
$2C_4H_{10}$ +	$13O_2$	→	$8CO_2$	+	$10H_2O$

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

<u>Matter and Changes</u>
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 → water → steam
Do NOT create new chemical species

2) Chemical Change – create new chemical species
$2H_20$ → $H_2 + O_2$

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 Cl_2 H_2 O_2
2) Pure compound such as NaCl or H_2O or $C_6H_{12}O_6$

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

<u>Naming Scheme</u>

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

<u>Cation (+ ion)</u>
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

<u>Anions</u>

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
O_2^{2-} Peroxide

Other polyatomic with oxygen end with ate or ite

ClO_4^- Perchlorate
ClO_3^- Chlorate
ClO_2^- Chlorite
ClO^- Hyporchlorite

NO_3^- Nitrate
NO_2^- Nitrite

Learn Common Polyatomic Ions in textbook

Naming Examples
Ammonium sulfide $(NH_4)_2S$
Iron (III) oxide Fe_2O_3
Iron (II) oxide FeO
Copper (II) cyanide $Cu(CN)_2$

* Use parenthesis if more than one polyatomic ion

<u>THINK IONS</u>
see this Al_2O_3 and think of the ions Al^{3+} O^{2-} name aluminum oxide
see this Na_2O and think of the ions Na^+ O^{2-} name sodium oxide
see this $Cu(NO_3)_2$ and think of ions Cu^{2+} NO_3^- name copper(II) nitrate
see this copper(II) nitrate and think of ions Cu^{2+} CN^- and then write $Cu(CN)_2$
Name does not give combining ratio – have to determine from ion charges!

<u>Naming with hydrogen</u>
(H is nonmetal but often named as if H^+ cation)

H_2S hydrogen sulfide
HCl hydrogen chloride
HBr hydrogen bromide
H_2O_2 hydrogen peroxide O_2^{2-} peroxide named like ionic)
PCl_5 phosphorous pentachloride
UF_6 uranium hexafluoride (some metal-nonmetals are more covalent than ionic)
$HClO_4$ hydrogen perchlorate (hydrogen like positive ion)
$HClO_3$ hydrogen chlorate
$HClO_2$ hydrogen chlorite

$HClO$ hydrogen hypochlorite

HNO_3 hydrogen nitrate
HNO_2 hydrogen nitrite
H_2SO_4 hydrogen sulfate
H_2SO_3 hydrogen sulfite
H_3N hydrogen nitride

LiH lithium hydride (ionic: hydrogen like negative ion)

<u>Binary Covalent Compounds Nomenclature</u>
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)

O_2F_2 dioxygen diflouride
HCL hydrogen chloride
NO nitrogen monoxide (old name: nitric oxide)
N_2O dinitrogen monoxide (old name: nitrous oxide)
NO_2 nitrogen dioxide
N_2O_3 dinitrogen trioxide
N_2O_5 dinitrogen pentoxide (drop final o or a in prefix if element begins with vowel)

Trivial Names

H_2O water
NH_3 ammonia
N_2H_4 hydrazine
PH_3 phospine

Acid Nomeclature

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_2S	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_2SO_4	hydrogen sulfate	sulfuric acid
H_2SO_3	hydrogen sulfite	sulfurous acid
HNO_3	hydrogen nitrate	nitric acid
HNO_2	hydrogen nitrite	nitrous acid
$HC_2H_3O_2$	hydrogen acetate	acetic acid
H_2CO_3	hydrogen carbonate	carbonic acid
H_3BO_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_2O	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.