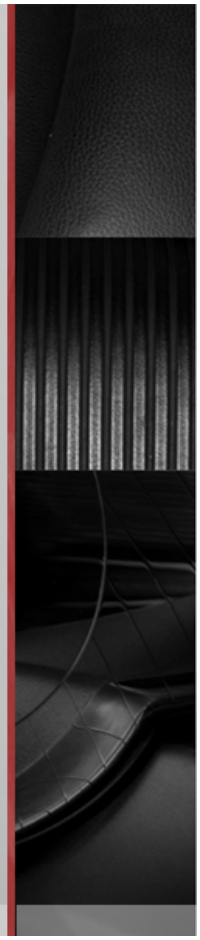
Ionic and Covalent Compounds

Honors Chemistry



Review: What are Ions?

- Ions are atoms that have either gained or lost valence electrons
- They have a charge, either posive or negave
- Negavely charged ions are called anions
- Posively charged ions are called caons
- Anions are almost always nonmetals, as a result their name is changed when they become ions
- Anions lose the last part of their name and it is replaced with *-ide*

Review: Anion Pracce Naming

- Chlorine→
- Selenium→
- Iodine→
- Oxygen→
- Nitrogen→
- Sulfur→

Review: Oxidaon Numbers

- The charge of an ion is called its oxidation #
- For the representative elements this can be determined by the number of valence electrons and the proximity to the noble gases
- To write the symbol for an ion, the chemical symbol is written followed by the oxidation number

Review Ion Symbol :

- Sodium→ Na^{+1}
- Silver→
- Potassium→
- Stronum → Sr^{+2}
- Aluminum→
- Lithium→
- Chlorine→
- Selenium→ Se^{-2}
- Iodine→
- Oxygen→
- Nitrogen→ N^{-3}
- Sulfur→

Oxidaon Numbers and Transion Metals

- Transition Elements often have more than one oxidation number
- These numbers are sometimes given on the periodic table.
- In the name of the compound, **you are alerted to the oxidation number by a roman numeral**
- I.e. Copper II has a 2+ charge, Copper I has a 1+ charge
- Lead IV has a 4+ charge, etc.

Name the charges of the cations:

a. Tin IV Sn^{+4}

b. Iron III Fe^{+3}

c. Titanium V Ti^{+5}

d. Iron II Fe^{+2}

I II III IV V VI VII

Common Oxidation #'s

Ti^{+4}, Cr^{+3}, V^{+5}, Ni^{+2}, Au^{+1}, Au^{+3}
Group 3: $^{+3}$

Group 12: $^{+2}$

Ion Symbol :

- Gold III→
- Zinc→
- Calcium→
- Nickel II→
- Tin IV→
- Lead II→

Ionic Bonds

Ionic bonds are formed between ions as one element gives up its electron(s) to a more electronegative atom.

Remember the **Octet Rule!!!!**

Cation: gives or loses one or more electrons m aking them positive (metals)

Anion: Takes or gains one or more electrons making them negative (nonmetals)

The charged **ions** are now attracted to each other because of the electrostatic charge difference and will combine to form a stable and neutral compound

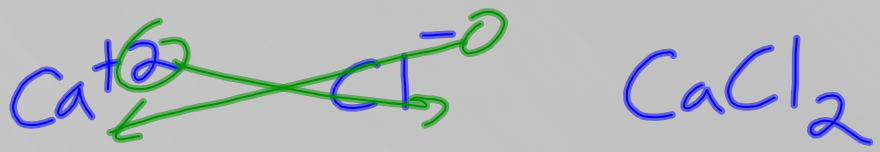
Ionic Bonds

Cations + Anions = ionic compound

Na^+ Cl^- $NaCl$

Sodium chloride

Any cation can bond with any anion and make a compound. How do we do this?



Ca^{+2} Mg^{+2} Na^{+1} Cu^{+1}
Sr^{+2} **cations** Li^{+1}
Zn^{+2}
Ti^{+4} Ni^{+2} Au^{+3} Au^{+1}
Cr^{+3} V^{+5} Pb^{+4} Fe^{+3} Ag^{+1}
K^{+1} Fe^{+2} Al^{+3} Mg^{+2}

F^- Cl^- O^{-2} Br^- N^{-3}
I^- **anions** Te^{-2}
S^{-2} P^{-3} As^{-3} Br^-

How Many to Balance?

Say it:

"SWAP n' DROP"

In order to write and predict ionic compounds, You must first convert two elements to ions and then you simply list two ions side by side with the metal on the left side:

Ca^{+2} cation N^{-3} anion

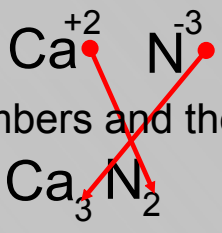
Since the charges will balance each other out in an ionic bond...

Ca^{+2}
Ca^{+2}
Ca^{+2}
+6 charge

N^{-3}
N^{-3}
-6 charge

SWAP n' DROP

Simply swap ...



and drop the numbers and then drop the charges.

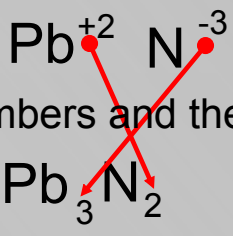
Ca_3N_2

The new compound is now electrically neutral and stable. To name it, simply name the first metal and name the ion:

Ex: "*Calcium nitride*"

Transition metals: SWAP n' DROP

Simply swap the numbers:

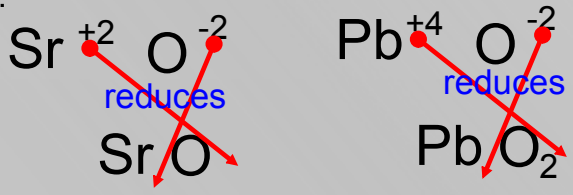


And drop the numbers and then drop the charges.

To name it, simply name the metal ion, write the roman numeral of its charge and then name the anion: Ex: "*Lead II nitride*"

SWAP n' DROP

If the numbers are multiples, reduce. If the number is "1", it is not written, it is just understood to be there.



The new compound is still named the same way:

Ex: "*Strontium oxide", "Lead IV oxide"**

**Note that the metal ion's name does not change*

Pracce:

What would the following ions make? What would they be called?

	Na^{+}	Fe^{+3}	Ca^{+2}	Al^{+3}	Cr^{+4}
O^{-2}					
F^{-}					
S^{-2}					
P^{-3}					
Br^{-}					

If you are given just the name and need the compound...

List the ions; then swap n' drop, reduce if necessary.:

Zinc chloride *Lead IV sulfide*

Zn^{+2} Cl^{-} Pb^{+4} S^{-2}

$ZnCl_2$ PbS_2

It's that easy!

Write the following compounds:

1. Sodium chloride
2. Zinc iodide
3. Aluminum sulfide
4. Tin IV oxide
5. Gallium nitride
6. Gold III fluoride

Vocabulary Quiz

1. A positively charged ion.
2. Something that conducts electricity when dissolved in a liquid
3. A repeating 3-D pattern of ions in a solid
4. The ionic compound's basic particle
5. A polyatomic ion with oxygen in it
6. A solution of metals
7. A covalently bonded structure with a charge
8. When two ions are attracted by the electrostatic difference between them
9. An ion consisting of one type of element
10. The idea that metals can conduct electricity because of free flowing electrons

Binary Compounds *V.* Polyatomic Ions

So far all the ions we have been dealing are monatomic ions and form **binary compounds**, (having only two ions)

However, many compounds are formed from **polyatomic ions**

Polyatomic ions are covalently bonded molecules that have a charge.

They act like regular ions when forming compounds. It is important to see them as a unit. In order to do so, most people keep them in parentheses.

Some common polyatomic ions:

Remember:Treat them like any other ion, just keep them in parentheses. JUST SWAP n' DROP!

Ammonium $(NH_4)^+$
Hydroxide $(OH)^-$
Chlorate $(ClO_3)^-$
Nitrate $(NO_3)^-$
Phosphate $(PO_4)^{-3}$
Sulfate $(SO_4)^{-2}$

They can be the **caon** ...

$(NH_4)^+ \quad + \quad O^{-2} \longrightarrow (NH_4)_2O$

They can be the **anion**...

$Fe^{+3} \quad + \quad (SO_3)^{-2} \longrightarrow Fe_2(SO_3)_3$

Or they can be **both**..

$(NH_4)^+ \quad + \quad (PO_4)^{-3} \longrightarrow (NH_4)_3(PO_4)$

Pracce:

formula name

Sr^{+2} + $(PO_4)^{-3}$ →

$(NH_4)^{+}$ + Br^{-} →

Mg^{+2} + $(NO_3)^{-}$ →

Ca^{+2} + $(SO_4)^{-2}$ →

Cu^{+2} + $(ClO_3)^{-}$ →

$(NH_4)^{+}$ + $(OH)^{-}$ →

Fe^{+3} + $(C_2H_3O_2)^{-}$ →

So why do we call them that?

Some polyatomic ions end in *-ide,* i.e. cyanide, hydroxide, etc.

Most polyatomic ions end in *-ate* or *ite*, a sign that they bond with oxygen. The **number of oxygens** determines how they are named.

oxyanions

hypo- least number of O's
-ite is less
-ate is more
per- is most number of O's

EXAMPLES:

hypo*chlor*ite, ClO
chlor***ite***, ClO_2
chlor***ate***, ClO_3
perchlor***ate***, ClO_4

$AgNO_3$
$AlAs$
Al_2O_3
AlP
$BaSe$
$BeCr_2O_7$
$CaBr_2$
$Ca(OH)_2$
Ca_2P_3
CuF
CuF_2
$CuTe$
$Fe\ O$
Fe_2O_3
FeP
$Fe_2(SO_3)_3$
$GaAs$
$GaCl_3$
Ga_2S_3
H_2O_2
KCl
KI
$LiClO_2$
$Mg(MnO_4)_2$
$NaBr$
NaF
NH_4ClO
$(NH_4)_2O$
NH_4OH
$(NH_4)_3(PO_4)$
$Ni(NO_2)_2$
$Ni(NO_3)_3$
$PbCl_2$
$PbCl_4$
PbO
PbS_2
$RbCl$
$SrCO_3$
TiN
ZnO

Covalent Bonds

In order to sasfy the octet rule, non-metals will oen share electrons rather than transfer them.

The valence electrons in a Lewis dot structure shows how these electrons are shared in what is called an covalent bond, which is a pair of electrons which can be found in the cloud of two atoms

electron pair

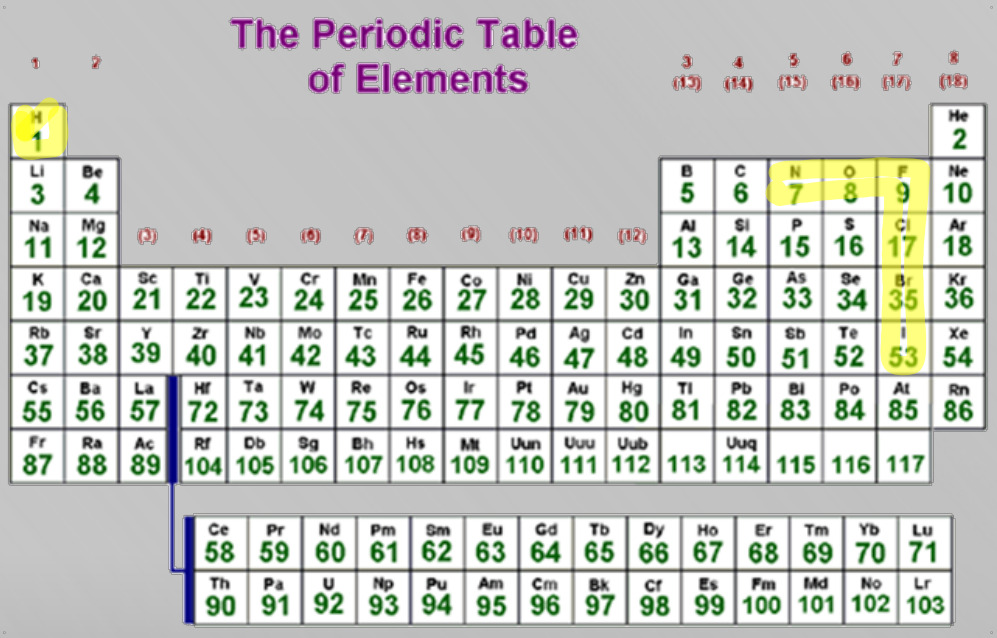
Diatomic molecules

Seven atoms cannot be found in nature alone, they always pair up and share electrons with each other. These are **diatomic molecules**

H_2, N_2, O_2, F_2, Cl_2, Br_2, I_2

Mnemonic device: "SECRET SEVEN". They are "double agents."

They are called by their name. To disnguish them from the individual atoms, individual atoms are called "elemental", i.e. elemental oxygen



Covalent Compounds are called **molecules**

How do we name them?

We use **prefixes** to tell the number of each **non-metal.**

The numbers do NOT reduce.

If the first element is single the prefix is not used.

mono-	one
di-	two
tri-	three
tetra-	four
penta-	five
hexa-	six
hepta-	seven
octa-	eight
nona-	nine
deca-	ten

Name the following compounds:

CO_2

NH_3

CO

SF_2

N_2F_6

CCl_4

How do you tell the difference between an ionic compound and a covalent compound?

Ionic compounds have a metal ion and a nonmetal ion!*

Label the following as ionic or covalent:

SO_2

SiO_2

SrO

CCl_4

$CaCl_2$

$CuCO_3$

PO_4^{3-}

Na_3PO_4

KI

$(NH_4)_2CO_3$

*The exception is ammonium which acts like a metal ion

Naming Acids

Acids are a special type of compound that are covalently bonded but dissociate in water like ionic compounds. They always contain **hydrogen** as their first element.

When naming acids, we classify them into two broad categories.

If the acid does not end in an **oxyanion,** it is a **binary acid**

If it has an **oxyanion**, it is an **oxyacid**

HI HF H_2S

Oxyacid

$HBrO$ $HBrO_3$

H_2SO_4 H_2CO_3

$HClO_4$

Binary acid

HBr

H_2Se

HCN

HCl

If the acid is **binary**,

Use the prefix **hydro-** instead of hydrogen, change the *-ide* of the anion to *-ic*. Finally add "acid" at the end.

Example:

HCl

Hydro- + chloride becomes chloric

hydrochloric acid

If given the name of the acid, work backwards.

1. Find ions
2. Swap n' drop

hydrosulfuric acid

H^+ S^{-2} H_2S

hydronitric acid

H^+ N^{-3}

H_3N

hydrocyanic acid

*hydrohydroxic acid

Oxyacids

These contain polyatomic ions that end with oxygen (oxyanions)

1. No hydro if "O". H_2SO_4

- Don't use the prefix for oxyacids. It is understood.

2. Look to see if it ends in *-ite* or *-ate*.

3. Change *-ite* to *-ous*, change *-ate* to *-ic*.

4. Add the word acid.

Which is which?

ACIDS	Covalent Compounds	IONIC COMPOUNDS
HI $HClO_4$ H_2CO_3 HCl HCN HBr	$BrCl_5$ SO_2 CO CO_2	NaF NH_4ClO NaBr $LiClO_2$ $(NH_4)_2O$ $Mg(MnO_4)_2$

Name the following compounds or write their formula

1. N_2
2. Sodium fluoride
3. PbO
4. SnS_2
5. FeF_3
6. S_2Br_4
7. Selenium diiodide
8. H_2CO_3
9. hydrofluoric acid
10. bromous acid
11. HI
12. HIO

Write the formula or the name

A	B	C	D
$SrCl_2$	CO	Silver chloride	Boron trifluoride
$RbMnO_4$	H_2S	Ammonium phosphite	Xenon tetrafluoride
$CuBr_2$	Sn_3N_2	Iron (III) carbonate	Chlorous acid
SeS_3	$HC_2H_3O_2$	Arsenic pentafluoride	Carbonic acid
HCN	$Sr(OH)_2$	Hydrosulfuric acid	Potassium acetate
H_3PO_4	$CuSO_4$	Bromous acid	Ammonium acetate
HCO_3	$Co_2(SO_4)_3$	Sulfuric acid	Copper (II) nitrate
CaS	CS_2	Sodium biphosphate	Tetraphosphorus trioxide
$NaClO_3$	HIO	Magnesium hydroxide	Ammonium carbonate
TiF_2	$NaClO_2$	Lead (IV) oxide	Sulfurous acid

If it is covalent, draw the **Lewis Dot Structure**