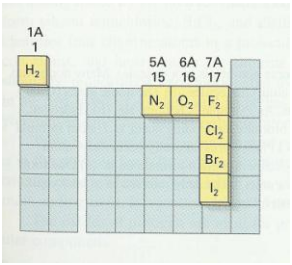
Formula Nomenclature

Latin for calling by name
Precise vocabulary for chemical communication

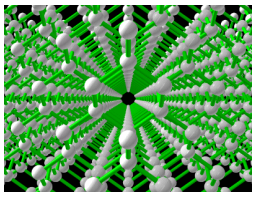
Elements

Mono-atomic (Monatomic) – single atoms
Examples: Cu Al C P
Di-atomic – two atoms (Must Know)
Examples: H_2 N_2 O_2 F_2 Cl_2 Br_2 I_2

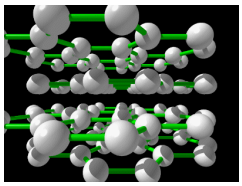


Poly-atomic – multiple atoms

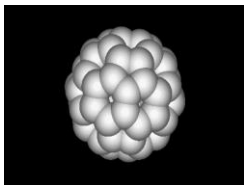
Examples: O_3 P_4 S_8 C_{60}



Diamond



Graphite

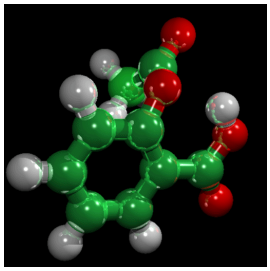


"Bucky Ball"

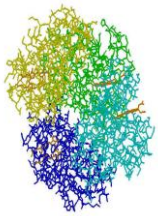
Molecules

Two or more atoms joined together chemically in a neutral unit

Water



Aspirin



Hemoglobin

Molecules can contain thousands of atoms

Binary Molecular Compounds

Binary = 2

Two Non-Metals or Metalloid + Non-Metal

First Word

Name of the element appearing first in the formula
Include a prefix to indicate # atoms

Second Word

Name of the element appearing second in the formula,
changed to end in –ide
Include prefix to indicate # atoms

Greek prefixes indicating numbers of atoms

1	mono– (omitted for first–named element)
2	di–
3	tri–
4	tetra–
5	penta–
6	hexa–
7	hepta–
8	octa–
9	nona–
10	deca–

final "a" & "o" of prefix omitted with oxides

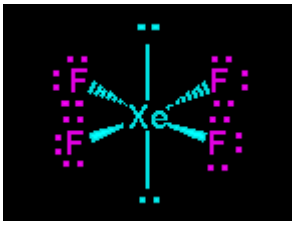
Examples

N_2O Dinitrogen Monoxide
N_2O_3 Dinitrogen Trioxide
Si_2Cl_6 Disilicon Hexachloride
CO Carbon Monoxide
CO_2 Carbon Dioxide
P_2O_5 Diphosphorus Pentoxide

Noble Gases

Chemically inert under most circumstances
Xenon reacts with fluorine only at extreme temperature and pressure

These are molecular (covalent bonding) compounds
Name as non-metals



XeF_2 xenon difluoride
XeF_4 xenon tetrafluoride
XeF_6 xenon hexafluoride

Two common names you need to know:

H_2O water NH_3 ammonia

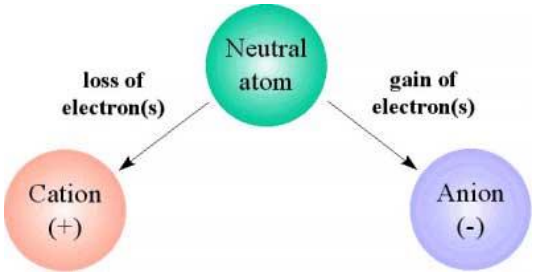
Write the proper formula for:

carbon monoxide	CO
phosphorus pentachloride	PCl_5
dinitrogen pentoxide	N_2O_5
silicon dioxide	SiO_2
sulfur tetrafluoride	SF_4

Name the following compounds:

Cl_2O_7	dichlorine heptoxide
P_4O_{10}	tetraphosphorus decoxide
SO_3	sulfur trioxide
NO	nitrogen monoxide
IF_5	iodine pentafluoride

Ions



Oxidation Number = charge on a monatomic ion

Ion Nomenclature

Symbol size of charge, sign of charge

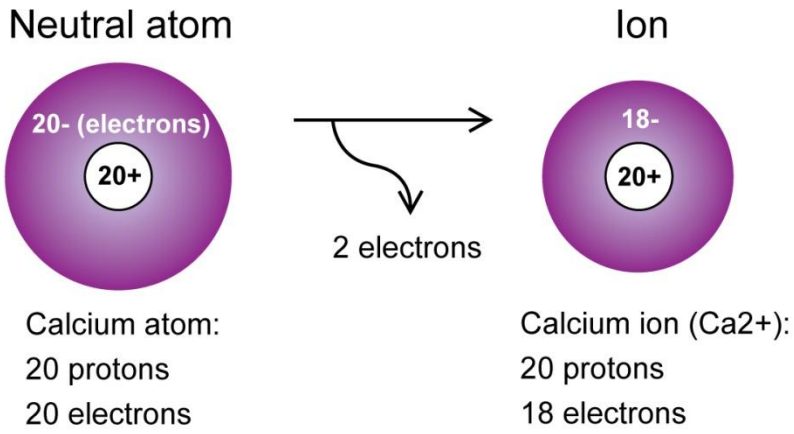
Examples:

Na^+ Ca^{2+} Fe^{3+} F^- S^{2-}

(1 is not shown, but understood)

Cations

Positive ions
Formed from loss of electrons
$\#p^+ > \#e^-$
Metals form cations
Named from parent ion + "ion"



Metal Cation Nomenclature

For Representative Metals
name the element and add the word ion after

Na^+ Sodium Ion
Al^{3+} Aluminum Ion
Ca^{2+} Calcium Ion
K^+ Potassium Ion

Transition Metals - more than one charge possible
name element, charge (in roman numerals) and then ion

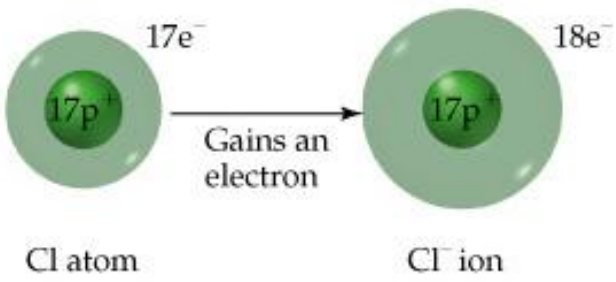
Fe^{3+} iron (III) ion (ferric)
Fe^{2+} iron (II) ion (ferrous)
Cu^+ copper (I) ion (cuprous)
Cu^{2+} copper (II) ion (cupric)

Anions

negative ions - formed from gain of electrons

$\#p^+ < \#e^-$

Nonmetals form anions

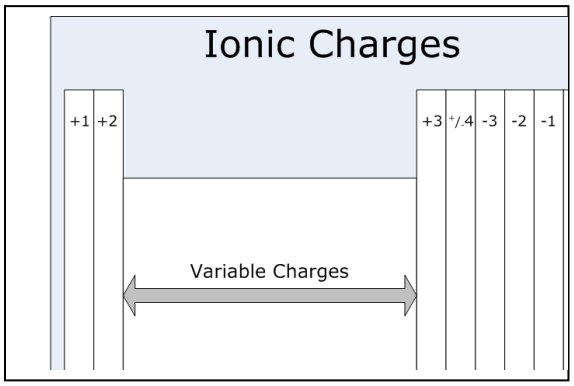


Name the root of the element + –ide

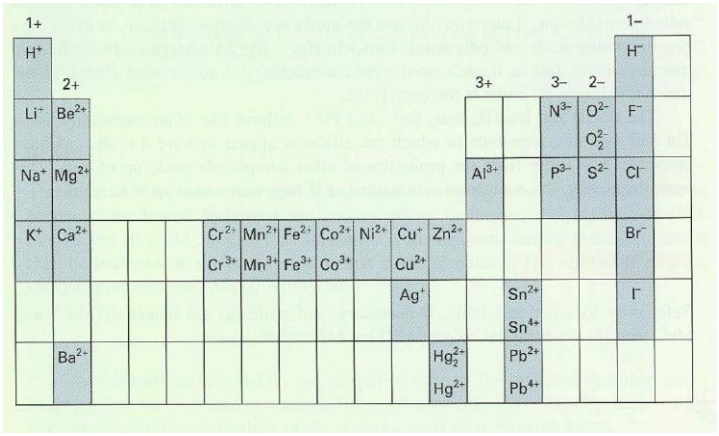
O^{2-}	oxide
F^-	fluoride
N^{3-}	nitride
S^{2-}	sulfide

Predicting Charge

Group 1A	+ (1 understood)
Group 2A	2+
Group 3A	3+
Transition	form cations with various charges
Group 5A	3–
Group 6A	2–
Group 7A	– (1 understood)



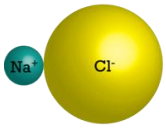
Common Mono-Atomic Ions

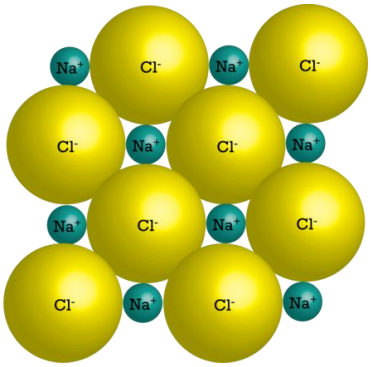


Ionic Compounds

Contain charged particles, ions
Compound is neutral (+ and – charges equal)
Not discrete units; 3–d arrays of (+) and (–) ions

Typically: metal + (non-metal or polyatomic ion)



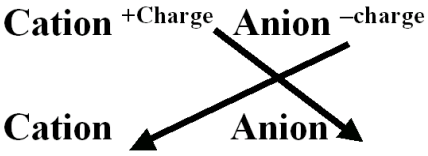


Charges arrange in 3D matrix

Simplest ratio = formula unit

Subscript Trick

Quick way to balance charges



For
Al^{3+} and O^{2-}
Al_2O_3

Na^+ and Cl^-	NaCl
K^+ and Br^-	KBr
Ca^{2+} and F^-	CaF_2
Ba^{2+} and S^{2-}	BaS
Li^+ and S^{2-}	Li_2S
Al^{3+} and O^{2-}	Al_2O_3

Compounds Containing Polyatomic Ions

Charged species containing more than one atom
Treat as single entity: (+) and (–) charges must balance
More than one polyatomic ion, use ( ) and subscript

NH_4^+ and SO_4^{2-} = $(NH_4)_2SO_4$

Ca^{2+} and OH^- = $Ca(OH)_2$

Polyatomic Ions

Ammonium	$(NH_4)^+$
Acetate	$(C_2H_3O_2)^-$ or $(CH_3COO)^-$
Hydroxide	$(OH)^-$
Chlorate	$(ClO_3)^-$
Chlorite	$(ClO_2)^-$
Nitrate	$(NO_3)^-$
Nitrite	$(NO_2)^-$
Sulfate	$(SO_4)^{2-}$
Hydrogen sulfate	$(HSO_4)^-$
Sulfite	$(SO_3)^{2-}$
Carbonate	$(CO_3)^{2-}$
Hydrogen carbonate	$(HCO_3)^-$
Phosphate	$(PO_4)^{3-}$

Naming Ionic Compounds

BaF_2	barium fluoride	
CaF_2	calcium fluoride	
NaBr	sodium bromide	
Mg_3N_2	magnesium nitride	
Al_2O_3	aluminum oxide	(alumina)
Li_3P	lithium phosphide	
AlN	aluminum nitride	
$CuCl_2$	copper (II) chloride	(cupric chloride)
CuCl	copper (I) chloride	(cuprous chloride)
FeN	iron (III) nitride	(ferric nitride)
Fe_3N_2	iron (II) nitride	(ferrous nitride)
$SnCl_4$	tin (IV) chloride	(stannic chloride)
$SnCl_2$	tin (II) chloride	(stannous chloride)

Naming Compounds Containing Polyatomic Ions

Name cation (transition metals- charge in parenthesis)
Name anion

$(NH_4)_2SO_4$	Ammonium Sulfate
$Co(NO_3)_3$	Cobalt (III) Nitrate
$PbCO_3$	Lead (II) Carbonate
$Mg_3(PO_4)_2$	Magnesium Phosphate

Binary Acids

Produce H^+ in solution

Binary Acids = Hydrogen + nonmetal

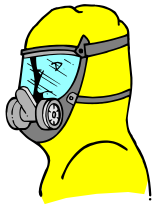
HYDRO + ROOT + IC ACID

H_2S	hydrosulfuric acid (hydrogen sulfide)
HCl	hydrochloric acid (Muriatic)
HBr	hydrobromic acid
HI	hydroiodic acid
HF	hydrofluoric acid

Oxy Acids

H + nonmetal + Oxygen H + polyatomic ion

–ate ions	root+ic acid
–ite ions	root+ous acid



$HClO_3$	chloric acid
$HClO_2$	chlorous acid
H_2SO_4	sulfuric acid
H_2SO_3	sulfurous acid
HNO_3	nitric acid
HNO_2	nitrous acid

Hints For " -Ates & - Ites"

Where X = N or Halide

Species	Acid	Salt
XO_4	per X ic	per X ate
XO_3	X ic	X ate
XO_2	X ous	X ite
XO	hypo X ous	hypo X ite

Some Oxy-Acids

phosphoric acid	H_3PO_4	
carbonic acid	H_2CO_3	
acetic acid	$H(C_2H_3O_2)$	(HOAc)
hydrofluoric acid	HF	

Complete This Table

cation formula	anion formula	anion name	acid name	acid formula
H^+		sulfate		
H^+				HBr
H^+	NO_3^-			
H^+		phosphate		
H^+			sulfurous	
H^+	ClO_2^-			
H^+			hydroiodic	
H^+	CO_3^{2-}			

Be able to complete these tables by memory before taking Unit Exam

Completed Table

cation formula	anion formula	anion name	acid name	acid formula
H^+	SO_4^{2-}	sulfate	sulfuric	H_2SO_4
H^+	Br^-	bromide	hydrobromic	HBr
H^+	NO_3^-	nitrate	nitric	HNO_3
H^+	PO_4^{3-}	phosphate	phosphoric	H_3PO_4
H^+	SO_3^{2-}	sulfite	sulfurous	H_2SO_3
H^+	ClO_2^-	chlorite	chlorous	$HClO_2$
H^+	I^-	iodide	hydroiodic	HI
H^+	CO_3^{2-}	carbonate	carbonic	H_2CO_3

Complete This Table

cation formula	anion formula	anion name	acid name	acid formula
H^+			acetic	
H^+	Cl^-			
H^+			hydrosulfuric	
H^+		chlorate		
H^+	-			HNO_2

The Completed Table

cation formula	anion formula	anion name	acid name	acid formula
H^+	$(C_2H_3O_2)^-$	acetate	acetic	$H(C_2H_3O_2)$
H^+	Cl^-	chloride	hydrochloric	HCl
H^+	S^{-2}	sulfide (sulphide)	hydrosulfuric	H_2S
H^+	ClO_3^-	chlorate	chloric	$HClO_3$
H^+	NO_2^-	nitrite	nitrous	HNO_2

Hydrates

Absorb water from atmosphere
Water becomes associated with structure

Adding Water to
Dry (anhydrous) $CuSO_4$

Changes crystal structure
Colored Indicators

Naming Hydrates

Anhydrous (without water) name "• n H2O's"

$CuSO_4 \cdot 5\ H_2O$ copper (II) sulfate pentahydrate
$Na_2CO_3 \cdot 10\ H_2O$ sodium carbonate decahydrate
$CaSO_4 \cdot 2\ H_2O$ calcium sulfate dihydrate

Compound + water ➔ hydrate

Hydrate ➔ compound + water

Desiccants = compounds that absorb water

Common Names (No systematic Pattern)

Alumina	aluminum oxide	Al_2O_3
Baking Soda	sodium hydrogen carbonate	$NaHCO_3$
Baking Soda	sodium bicarbonate	$NaHCO_3$
Cream of Tarter	potassium hydrogen tartrate	$KHC_2H_4O_6$
Epsom Salt	magnesium sulfate heptahydrate	$MgSO_4 \cdot 7\ H_2O$
Grain Alcohol	ethanol	C_2H_5OH
Lye	sodium hydroxide	$NaOH$
Potash	potassium carbonate	K_2CO_3
Quicksilver	mercury	Hg
Washing Soda	sodium carbonate decahydrate	$Na_2CO_3 \cdot 10\ H_2O$
Wood Alcohol	methanol	CH_3OH

Summary Of Nomenclature

Table 6.9 Summary of Nomenclature System

Substance	Name	Formula
Element	Name of element	Symbol of element; exceptions: H_2, N_2, O_2, F_2, Cl_2, Br_2, I_2
Compounds made up of two nonmetals	First element in formula followed by second, changed to end in *-ide,* each element preceded by prefix to show the number of atoms in the molecule	Symbol of first element in name followed by symbol of second element, with subscripts to show number of atoms in molecule
Acid	Most common: middle element changed to end in *-ic* One more oxygen than *-ic* acid: add prefix *per-* to name of *-ic* acid One fewer oxygen than *-ic* acid: change ending of *-ic* acid to *-ous* Two fewer oxygens than *-ic* acid: add prefix *hypo-* to name of *-ous* acid No oxygen: Prefix *hydro-* followed by name of second element changed to end in *-ic*	H followed by symbol of nonmetal followed by O (if necessary), each with appropriate subscript. *Memorize the following:* Chloric acid $HClO_3$ Nitric acid HNO_3 Sulfuric acid H_2SO_4 Carbonic acid H_2CO_3 Phosphoric acid H_3PO_4
Monatomic cation	Name of element followed by ion; if element forms more than one monatomic cation, elemental name is followed by ion charge in Roman numerals and in parentheses	Symbol of element followed by superscript to indicate charge
Monatomic anion	Name of element changed to end in *-ide*	Symbol of element followed by superscript to indicate charge
Polyatomic anion from total ionization of oxyacid	Replace *-ic* in acid name with *-ate,* or replace *-ous* in acid name with *-ite,* followed by ion	Acid formula without hydrogen plus superscript showing negative charge equal to number of hydrogens removed from acid formula
Polyatomic anion from step-by-step ionization of oxyacid	Hydrogen followed by name of ion from total ionization of acid (dihydrogen in the case of $H_2PO_4^-$)	Acid formula minus one (or two for H_3PO_4) hydrogen(s), plus superscript showing negative charge equal to number of hydrogen removed from acid formula
Other polyatomic ions	Ammonium ion Hydroxide ion	NH_4^+ OH^-
Ionic compound	Name of cation followed by name of anion	Formula of cation followed by formula of anion, each taken as many times as necessary to yield a net charge of zero (polyatomic ion formulas enclosed in parentheses if taken more than once)
Hydrate	Name of anhydrous compound followed by (number prefix)hydrate, where (number prefix) indicates the number of water molecules associated with one formula unit of anhydrous compound	Formula of anhydrous compound followed by "· n H_2O" where n is number of water molecules associated with one formula unit of anhydrous compound

Assignment

Start Taking Unit 5 Practice Test
Blackboard only records highest score
Take until multiple 100's have been scored (questions are variable)
(Gives sense of test exam format and content)

The Practice Quiz is very similar to the Unit Exam
Success on Unit exam is directly related to practice exam experiences

By now, the elements, the diatomic molecules, and polyatomic ions should have been memorized.