NOMENCLATURE

I. Binary Molecular (covalent) Compounds (2 non-metals)

- Decide the first element in the name (it will also be the first in the formula)
- The first element's name remains unchanged.
- The second element's name gets an –ide ending.
- Both elements get a prefix to denote the number of atoms of that element in the compound

  EXCEPT mono is not used in front of the first element.

- When the prefix ends in "a" or "o" and the element name begins with "a" or "o" the final vowel of the prefix is dropped to make pronunciation easier.
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Number of Atoms	Prefix
1	mono
2	di
3	tri
4	tetra
5	penta
6	hexa
7	hepta
8	octa
9	nona
10	deca

Examples:

Write the name of the following compounds: a) CO b) Cl_2O_7 c) ICl_3

Write formulas for the following compounds: a) dichlorine heptoxide b) sulfur hexafluoride

II. Ionic compounds

Oxidation Numbers

- Represent how many electrons an atom has lost (positive oxidation number) or gained (negative oxidation number) when it is chemically combined with another element.

Rules for oxidation numbers:

- Group IA metals = +1 (always)
- Group IIA metals = +2 (always)

- Group VIA nonmetals = -2 *in binary ionic compounds*
- Group VA nonmetals = -3 in *binary ionic compounds*
- F = -1 (always)
- Cl, Br, I = -1 (except when attached to a more electronegative element: O or F)
- O = -2 (almost always)
- Al = +3, Zn = +2, Cd = +2, Ag = +1
- H = +1 except when attached to a metal then H= -1.

For ions the sum of the oxidation numbers = the charge on the ion. For neutral molecules the sum of all the oxidation numbers = 0. For elements the oxidation number = 0.

Examples:

Predict the oxidation number for each atom in the following compounds: a) $K_2Cr_2O_7$ b) PO_4^{3-} c) FeH_2

Naming Binary Ionic Compounds (salts) – metal and a non-metal.

- The cation (+) comes first, followed by the anion (-)

A. Metal ions with fixed charges (oxidation numbers)

- See oxidation number rules for the metals with fixed charges.
- The first element's name remains unchanged
- The second element's name gets an –ide ending.

Examples:

Name: a) MgS b) $CaCl_2$

Give the formulas for: a) aluminum oxide b) lithium oxide c) calcium nitride

B. Metal ions with variable charges (oxidation numbers)

- Are followed by a Roman numeral to denote their charge (new/Stock naming system).
- Older naming system is derived from the Latin element name with an –ous or –ic ending.

+1 (-ous) +2(-ic)	**+2 (-ous) +3(-ic)**	**+2 (-ous) +4 (-ic)**
Cu^+ copper (I) (cuprous)	Co^{2+} cobalt (II) (cobaltous)	Pb^{2+} lead (II) (plumbous)
Cu^{2+} copper (II) (cupric)	Co^{3+} cobalt (III) (cobaltic)	Pb^{4+} lead (IV) (plumbic)
Hg_2^{2+} mercury (I) (mercurous)	Fe^{2+} iron (II) (ferrous)	Sn^{2+} tin (II) (stannous)
Hg^{2+} mercury (II) (mercuric)	Fe^{3+} iron (III) (ferric)	Sn^{4+} tin (IV) (stannic)

- The first element has the name as shown above.
- The second element gets an –ide ending.

Examples:

Name the following: a) CuO b) NaBr c) AlN d) PbI_4 e) Fe_2O_3 f) Hg_2Cl_2

Give formulas for the following: a) manganese (IV) oxide b) gold (I) sulfide c) plumbous oxide

C. Polyatomic ions

- Charged groups of bonded atoms.
- Do not change their name

Common polyatomic ions:

NH_4^+	ammonium	MnO_4^-	permanganate
OH^-	hydroxide	$C_2H_3O_2^-$	acetate
H^-	hydride	$C_2O_4^{2-}$	oxalate
CN^-	cyanide	CrO_4^{2-}	chromate
SCN^-	thiocyanate	$Cr_2O_7^{2-}$	dichromate

Oxyanions ending in ----ate:

- Polyatomic ions containing oxygen and a non-metal

IIIA	IVA	VA	VIA	VIIA
BO_3^{3-} borate	CO_3^{2-} carbonate	NO^{3-} nitrate	---	---
	SiO_3^{2-} silicate	PO_4^{3-} phosphate	SO_4^{2-} sulfate	ClO_3^- chlorate
		AsO_4^{3-} arsenate	SeO_4^{2-} selenate	BrO_3^- bromate
			TeO_4^{2-} tellurate	IO_3^- iodate

Other oxyanions:

- Memorize the –ate oxyanions then change the name according to the number of oxygens.
- The charge on the oxyanion does not change when the number of oxygens is changed.

Prefixes and suffixes for oxyanions

2 oxygens less than --ate ion hypo------ite	1 oxygen less than --ate ion ------ite	--ate ion ------ate	1 oxygen more than --ate ion per------ate
ClO^- hypochlorite ion	ClO_2^- chlorite ion	ClO_3^- chlorate ion	ClO_4^- perchlorate ion

- Note: only Cl, Br, and I commonly have all of the oxyanions. B and C only commonly have the —ate ion, the rest of the elements above have the –ate and –ite forms.

Examples of oxyanions:

Name the following: a) PO_3^{3-} b) NO_2^- c) TeO_2^{2-} d) IO_4^-

Give the formulas for the following: a) bromite ion b) sulfite ion c) silicite ion d) arsenite ion

Acid anions:

- All negative ions with a –2 or –3 charge can form acid anions by adding one or more hydrogens
- Addition of one hydrogen to the anion decreases the charge by one and is named by writing *hydrogen* in front of the anion name.
- Addition of two hydrogens decreases the charge by two and is named by writing *dihydrogen* in front of the anion name

Example: HPO_4^{2-} is the hydrogen phosphate ion, $H_2PO_4^-$ is the dihydrogen phosphate ion

- Compounds containing acid anions are called *acid salts*

Examples of ionic compounds containing polyatomic ions:

Write the formulas for the following: a) calcium hypochlorite b) chromium (III) sulfate

c) copper (II) periodate d) sodium sulfite e) barium arsenite f) ammonium chlorite

Give the names for the following: a) $Mg(ClO_4)_2$ b) $KHCO_3$ c) $FePO_4$ d) $Mg(H_2PO_4)_2$ e) $Ag_2C_2O_4$ f) $Pb_3(PO_3)_4$

Hydrates:

- An ionic compound containing a fixed number of water molecules
- Name the ionic compound followed by ----hydrate
- Use a prefix to denote the number of water molecules.

Example:

Name the following: a) $CaCl_2 \cdot 6H_2O$ b) $LiClO_4 \cdot 3H_2O$ c) $MgCO_3 \cdot 5H_2O$

III. Acids and Bases

Arrhenius Definition:

- An acid is a molecular compound that ionizes in water to form a solution containing H^+ ions and anions.
- A base ionizes in water to give a solution containing OH^- ions and cations.

Binary Acids:

- When in their natural (gaseous) state, they are named as binary covalent compounds without the prefixes.
- When in an aqueous solution, they behave differently and are named hydro-----ic acid.

Example:

Name the following: a) $HF_{(g)}$ and $HF_{(aq)}$ b) $H_2S_{(g)}$ and $H_2S_{(aq)}$ c) $HCl_{(g)}$ and $HCl_{(aq)}$

Oxyacids (acids derived from oxyanions):

- ---ate ions become ---ic acids
- the formula for the acid has as many hydrogens as charges on the oxyanion.

Example: SO_4^{2-} is the sulfate oxyanion. Its oxyacid is H_2SO_4 and is named sulfuric acid.

Note the root name for sulfur derived oxyacids is *sulfur* instead of *sulf*

Prefixes and suffixes for oxyacids:

2 oxygens less than ---ic acid hypo---ous acid	1 oxygen less than ---ic acid ---ous acid	---ic acid ---ic acid	1 oxygen more than ---ic acid per---ic acid
HClO hypochlorous acid	$HClO_2$ chlorous acid	$HClO_3$ chloric acid	$HClO_4$ perchloric acid

Example:

Name the following: a) H_3PO_3 b) HNO_2 c) H_2TeO_2 d) HIO_4

Give formulas for the following: a) bromous acid b) sulfurous acid c) hypoiodous acid

Other acids:

HCN hydrocyanic acid $HC_2H_3O_2$ acetic acid $H_2C_2O_4$ oxalic acid

Bases:

- Ionic bases are named as for ionic compounds – most are formed from group IA and IIA cations. Many are hydroxides.
- Most bases are molecular. Many of them are ammonia and its compounds.

  Ammonia : $NH_{3(g)}$ Ammonia in solution: $NH_{3(aq)}$ or NH_4OH: ammonium hydroxide