SCH 3UI Unit 4 Outline:
Nomenclature

Lesson	Topics Covered	Homework Questions and Assignments
1	**Note: Nomenclature of Binary Ionic Compounds** • definition of binary ionic compounds • multivalent metal ions, Stock system • classical naming system (ous/ic)	• complete handout: Nomenclature #1: Binary Ionic Compounds
2	**Note: Naming Compounds with Polyatomic Ions** • ates • ites • per___ates • hypo___ites	• complete handout: Nomenclature #2: Polyatomic Ionic Compounds • be sure you understand the "system" for naming "ides", "hypo___ites", "ites", "ates" and "per___ates" in preparation for the next lesson on naming acids
3	**Note: Naming Acids** • definition of acid • binary acids • oxy-acids	• review the different naming systems for naming binary vs. oxy-acids • complete handout: complete handout: Nomenclature #4: Acids and Review
4	**Note: Odds and Ends When Naming Ionic Compounds** • peroxides • complex ions with hydrogen • hydrates **Assignment**: Classical and IUPAC Naming	• complete handout Nomenclature #5: Odds and Ends When Naming Ionic Compounds • optional review: pages 96-97 in text: Q 15, 16, 17, 19, 20 • review for a quiz on nomenclature of ionic compounds and acids (what we have done so far) at the beginning of our next class
5	**Quiz**: Nomenclature of Ionic Compounds and Acids (first 20 minutes) **Note: Nomenclature of Binary Covalent Compounds** • definition of binary covalent compounds • prefix system of naming	• complete Handout: Nomenclature #6: Binary Covalent Compounds • optional practice sheet: Nomenclature #7: Final Practice • work on Unit #4 Review: Chemical Nomenclature
6	**Unit Test**	Date:

aluminum		$A\ell^{3+}$	acetate	$(C_2H_3O_2^{1-})$	CH_3COO^{1-}
ammonium		NH_4^{1+}	borate		BO_3^{3-}
antimony (III)	*(antimonous)*	Sb^{3+}	bromate		BrO_3^{1-}
antimony (V)	*(antimonic)*	Sb^{5+}	bromide		Br^{1-}
arsenic (III)	*(arsenous)*	As^{3+}	bromite		BrO_2^{1-}
arsenic (V)	*(arsenic)*	As^{5+}	carbide		C^{4-}
barium		Ba^{2+}	carbonate		CO_3^{2-}
bismuth (III)	*(bismuthous)*	Bi^{3+}	chlorate		$C\ell O_3^{1-}$
bismuth (v)	*(bismuthic)*	Bi^{5+}	chloride		$C\ell^{1-}$
cadmium		Cd^{2+}	chlorite		$C\ell O_2^{1-}$
calcium		Ca^{2+}	chromate		CrO_4^{2-}
carbon		C^{4+}	cyanate		OCN^{1-}
cesium		Cs^{1+}	cyanide		CN^{1-}
chromium (II)	*(chromous)*	Cr^{2+}	dichromate		$Cr_2O_7^{2-}$
chromium (III)	*(chromic)*	Cr^{3+}	dihydrogen phosphate		$H_2PO_4^{1-}$
cobalt (II)	*(cobaltous)*	Co^{2+}	fluoride		F^{1-}
cobalt (III)	*(cobaltic)*	Co^{3+}	hydrogen carbonate	(*bicarbonate*)	HCO_3^{1-}
copper (I)	*(cuprous)*	Cu^{1+}	hydrogen phosphate		HPO_4^{2-}
copper (II)	*(cupric)*	Cu^{2+}	hydrogen sulfate	(*bisulfate*)	HSO_4^{1-}
gold (I)	*(aurous)*	Au^{1+}	hydrogen sulfide	(*bisulfide*)	HS^{1-}
gold (III)	*(auric)*	Au^{3+}	hydrogen sulfite	(*bisulfite*)	HSO_3^{1-}
hydrogen		H^{1+}	hydride		H^{1-}
hydronium		H_3O^{1+}	hydroxide		OH^{1-}
iron (II)	*(ferrous)*	Fe^{2+}	hypobromite		BrO^{1-}
iron (III)	*(ferric)*	Fe^{3+}	hypochlorite		$C\ell O^{1-}$
lead (II)	*(plumbous)*	Pb^{2+}	hypoiodite		IO^{1-}
lead (IV)	*(plumbic)*	Pb^{4+}	iodate		IO_3^{1-}
lithium		Li^{1+}	iodide		I^{1-}
magnesium		Mg^{2+}	iodite		IO_2^{1-}
manganese (II)	*(manganous)*	Mn^{2+}	nitrate		NO_3^{1-}
manganese (IV)	*(manganic)*	Mn^{4+}	nitride		N^{3-}
mercury (I)	*(mercurous)*	Hg^{1+}	nitrite		NO_2^{1-}
mercury (II)	*(mercuric)*	Hg^{2+}	oxalate		$C_2O_4^{2-}$
nickel (II)	*(nickelous)*	Ni^{2+}	oxide		O^{2-}
nickel (III)	*(nickelic)*	Ni^{3+}	perbromate		BrO_4^{1-}
phosphorus (III)	*(phosphorous)*	P^{3+}	perchlorate		$C\ell O_4^{1-}$
phosphorus (V)	*(phosphoric)*	P^{5+}	periodate		IO_4^{1-}
potassium		K^{1+}	permanganate		MnO_4^{1-}
silicon		Si^{4+}	phosphate		PO_4^{3-}
silver		Ag^{1+}	phosphide		P^{3-}
sodium		Na^{1+}	phosphite		PO_3^{3-}
strontium		Sr^{2+}	sulfate		SO_4^{2-}
tin (II)	*(stannous)*	Sn^{2+}	sulfide		S^{2-}
tin (IV)	*(stannic)*	Sn^{4+}	sulfite		SO_3^{2-}
titanium		Ti^{3+}	thiocyanate		SCN^{1-}
zinc		Zn^{2+}	thiosulfate		$S_2O_3^{2-}$

Nomenclature #1: Binary Ionic Compounds

1. Write the chemical formulas for the following binary ionic compounds:

barium oxide	lithium sulfide
magnesium bromide	strontium iodide
calcium sulfide	hydrogen bromide
lithium oxide	potassium chloride
cadmium fluoride	silver sulfide
potassium phosphide	zinc carbide
manganese (IV) sulfide	cobalt (II) bromide
manganese (II) carbide	phosphorus (V) nitride
gold (I) iodide	nickel (III) phosphide
iron (II) bromide	copper (II) sulfide
aluminum sulfide	silicon iodide
lead (IV) carbide	aluminum fluoride
arsenic (V) nitride	mercury (I) phosphide
cobalt (III) phosphide	cesium nitride
magnesium oxide	phosphorus (III) chloride

2. Name the following binary compounds. Use the "Stock" system where necessary:

Li_4C	Ba_3N_2
$MgBr_2$	$A\ell_2O_3$
$CaC\ell_2$	NaF
BaO	$ZnBr_2$
Ag_3N	KI
SrS	Cd_3P_2
BiH_5	$AgC\ell$
$AuBr_3$	CoO
Mn_3N_4	MnS_2
FeF_2	Pb_2C
$NiC\ell_2$	Sr_3P_2
HgO	CuF
$CoBr_3$	$NiBr_3$
CrS	FeN
NiN	SiO_2
SnO_2	Sb_2S_5
Au_3P	AsH_3

Polyatomic Ionic Compounds

Recall that "poly" means _____. Polyatomic ions are ions that are made of _____ different types of atoms chemically bonded together. They often (but not always) contain _____.

1. **The most common form of the polyatomic ion is given the "_____" ending**:

NO_3^{1-}	is the _____ ion	SO_4^{2-}	is the _____ ion
PO_4^{3-}	is the _____ ion	CO_3^{2-}	is the _____ ion
$C\ell O_3^{1-}$	is the _____ ion	IO_3^{1-}	is the _____ ion
BO_3^{3-}	is the _____ ion	CH_3COO^{1-}	is the _____ ion

2. **If the ion contains _____ than the most common ("_____") form, then it is given the "_____" ending:**

NO_2^{1-}	is the _____ ion	SO_3^{2-}	is the _____ ion
PO_3^{3-}	is the _____ ion	$C\ell O_2^{1-}$	is the _____ ion
IO_2^{1-}	is the _____ ion	BO_2^{3-}	is the _____ ion

(the carbonite ion, , does not exist)

3. **If the ion contains _____ than the "_____" ion, then it is given the prefix "_____" with the "_____" ending:**

SO_2^{2-}	is the _____ ion	PO_2^{3-}	is the _____ ion
$C\ell O^{1-}$	is the _____ ion	IO^{1-}	is the _____ ion

4. **If the ion contains _____ than the most common ("_____") form, then it is given the prefix "_____" with the "_____" ending**

$C\ell O_4^{1-}$	is the _____ ion
IO_4^{1-}	is the _____ ion
MnO_4^{1-}	is the _____ ion

Summary example:

$C\ell^{1-}$ _____
$C\ell O^{1-}$ _____
$C\ell O_2^{1-}$ _____
$C\ell O_3^{1-}$ _____
$C\ell O_4^{1-}$ _____

Notice that all of these ions have a valence (charge) of 1– . The "ate/ite" naming system does not tell us the charge of the ion, it tells only how many oxygen atoms are present. The ions that you need to know are on your ion chart, so you can look them up.

The Rules for writing chemical formulas of compounds containing polyatomic ions:

Never change or "reduce" the chemical formula of a polyatomic ion.

eg. the oxalate ion, $C_2O_4^{2-}$ CANNOT be reduced to lower terms! The oxalate ion contains 2 carbon and 4 oxygen atoms covalently bonded together, that never changes!!

It may help to keep things straight if you write the chemical formula of polyatomic ion in brackets, and write its charge outside the brackets. You CANNOT change what is inside of the brackets!!

If, after you criss-cross the charges, the sub-script outside the brackets is one (1), you MUST remove the brackets. If the subscript is greater than one, the brackets MUST remain.

eg. calcium hydroxide chromium (III) phosphite

Nomenclature #2: Polyatomic Ionic Compounds

1. Name the following compounds (include Roman Numerals when necessary):

Na_2SO_4	$A\ell PO_4$
$A\ell\ (C\ell O_4)_3$	$AsPO_3$
$Ni(OH)_3$	$AgBrO_3$
$Pb(IO_3)_2$	K_3P
HgCN	$Mg(IO_4)_2$
$Cd(BrO)_2$	$Au_2S_2O_3$
KSCN	$Bi(IO_2)_3$
$Co(BrO_4)_3$	$Si(NO_3)_4$
$CuCH_3COO$	$NH_4C\ell O_3$
$P(BrO_2)_3$	$NiBO_3$
$Fe(MnO_4)_2$	$SnCrO_4$
$Cr_2(Cr_2O_7)_3$	$Ba(C\ell O)_2$
$Pb(C\ell O_2)_4$	$Pb(SO_3)_2$

2. Write the chemical formula for the following ionic compounds:

zinc carbonate	aluminum hypochlorite
calcium phosphate	cadmium phosphate
iron (III) sulfate	mercury (II) chlorite
potassium phosphite	magnesium hydroxide
iron (II) chlorate	cobalt (II) carbonate
tin (IV) nitrite	lithium thiocyanate
lead (IV) dichromate	silver sulfite
ammonium sulfite	arsenic (III) perbromate
nickel (III) acetate	nickel (II) chromate
antimony (V) cyanide	iron (II) carbide
mercury (I) permanganate	gold (III) hypoiodite
zinc chloride	copper (II) oxalate
manganese (II) thiosulfate	chromium (III) phosphide

Nomenclature #3: Practice Naming Binary and Oxy-acids

The Rules:

- if the name of the ion ends in "ide", name the acid _____
- if the name of the ion ends in "ate", change the "ate" suffix to _____
- if the name of the ion ends in "ite", change the "ite" suffix to _____

Name of Ion	Formula of Ion	Formula of Acid	Suffix on the Name of the Ion	Name of Acid
acetate				
borate				
bromate				
bromide				
bromite				
carbonate				
chlorate				
chloride				
chlorite				
chromate				
cyanide				
dichromate				
fluoride				
hypobromite				
hypochlorite				
hypoiodite				
iodide				
iodate				
oxalate				
perbromate				
perchlorate				
periodate				
permanganate				
phosphate				
phosphide				
phosphite				
sulfate				
sulfide				
sulfite				
thiocyanate				
thiosulfate				

Nomenclature #3: Naming Acids

1. Name the following binary acids. These acids contain only hydrogen and one other element. Their names are always "hydro_____ic acid". ("Hydro" tells you it is a binary acid)

HI	HF
H_3P	HBr
$HC\ell$	H_2S

2. Name these oxyacids. If the acid contains the "ate" ion, then it becomes the "ic" acid. The "ite" ion, becomes the "ous" acid. Do not use "hydro" in these names. Hydro is only for binary acids.

HNO_3	HIO
H_3PO_4	H_2CO_3
$HC\ell O_2$	HCH_3COO
$HBrO_4$	H_2SO_3
HNO_2	H_3PO_3

3. Write the chemical formulas for these acids. Remember, "hydro" means it is a binary acid (no oxygen)

nitric acid	hydrobromic acid
nitrous acid	hypobromous acid
phosphoric acid	bromous acid
phosphorous acid	bromic acid
hydrophosphoric acid	perbromic acid
sulfuric acid	perchloric acid
sulfurous acid	chloric acid
hydrosulfuric acid	chlorous acid
carbonic acid	hypochlorous acid
hydroiodic acid	hydrochloric acid
hypoiodous acid	acetic acid
iodous acid	hydrofluoric acid
iodic acid	oxalic acid
periodic acid	chromic acid

4. Name the following acids. You may have to use the naming rules to figure some of them out.

HBr	H_3BO_3
H_2SO_3	HIO
HNO_3	H_2CO_3
H_2S	$HC\ell O_4$
$H_2Cr_2O_7$	HF
H_2SO_4	HCH_3COO
$HC\ell$	H_3BO_2

Nomenclature #4: Acids and Review

1. Name the following compounds. If they begin with hydrogen, name them as acids.

$Sb(NO_2)_3$	HIO
$(NH_4)_2CO_3$	$LiC\ell O_4$
$HC\ell O_2$	HCH_3COO
Au_3PO_3	Cu_3BO_3
HNO_2	H_3PO_3
MnO_2	$Fe(OH)_3$
H_2SO_3	$Hg_2C_2O_4$
HIO_2	H_2CO_3
H_2S	$HC\ell O_4$
H_3PO_4	HCN
H_3P	$Co_2(Cr_2O_7)_3$
$HC\ell$	$HBrO_2$
Mg_3N_2	$Sn(S_2O_3)_2$
HIO_4	$P(SCN)_3$
H_3BO_3	HF

2. Write the chemical formulas for the following compounds. Remember, "hydro" means a binary acid.

nitric acid	hydrochloric acid
gold (III) thiocynate	chromic acid
bromic acid	potassium dichromate
phosphorous acid	cadmium borate
ammonium hydroxide	perbromic acid
chromium (III) chlorate	bismuth (V) phosphide
nickel (II) iodite	hydrobromic acid
hydrosulfuric acid	chlorous acid
carbonic acid	calcium hydroxide
iron (II) fluoride	lead (IV) cyanide
hypoiodous acid	acetic acid
arsenic (V) acetate	zinc carbonate
lead (II) oxalate	oxalic acid
periodic acid	antimony (III) thiosulfate
cesium carbide	ammonium perbromate

Nomenclature #5: Odds And Ends when Naming Ionic Compounds

1. Write correct formulae for each of the following names:

sodium hypochlorite (bleach)	mercury (II) periodate
manganese (IV) oxide	tin (IV) bromate
potassium peroxide	zinc peroxide
chromium (II) sulfate	chromium (III) hydrogen sulfate
iron (III) acetate	silver peroxide
tin (IV) iodite	lead (IV) hydrogen chromate
lithium peroxide	cobalt (II) perchlorate
arsenic (V) thiosulfate	gold (III) fluoride
calcium permanganate	sodium peroxide
aluminum thiocyanate	strontium cyanate
copper (II) hydrogen carbonate	lead (IV) hypoiodite
silver dichromate	iron (III) borate
ammonium cyanide	antimony (III) hydrogen sulfite
mercury (II) acetate dihydrate	
silver hydrogen chromate tetrahydrate	
copper (II) sulfate pentahydrate	
copper (I) carbonate heptahydrate	
iron (III) dihydrogen phosphite nonahydrate	

2. Write the IUPAC names for the following compounds. Use Roman numerals when necessary.

Na_2O_2	$Hg(C\ell O_4)_2$
KNO_2	$Zn(OH)_2$
$CrSO_4$	$Cr(HSO_3)_3$
$Fe(CH_3COO)_3$	Li_2O_2
AuF_3	$Ca(HCrO_4)_2$
$HgMnO_4$	NaOCN
$Pb(IO)_2$	$Sn(H_2PO_4)_2$
$CuHSO_4$	$A\ell_2(Cr_2O_7)_3$
Ag_2HPO_3	H_2O_2
$NiPO_4$	$Pb(HCO_3)_4$
$Co(IO_2)_2$	$Sb_3(BO_3)_5$
$MnO_2 \cdot 4\ H_2O$	
$CuNO_3 \cdot 6\ H_2O$	
$NaCH_3COO \cdot 3\ H_2O$	
$AuCN \cdot 8\ H_2O$	

Nomenclature #6: Binary Covalent Compounds

- Ionic compounds are formed when _____ atoms bond with _____ atoms. They are named using the rules for naming ionic compounds that we have been learning up until now.
- Covalent (molecular) compounds are formed when two or more _____ atoms are bonded together. There is separate IUPAC system of naming that is used for ***binary*** covalent compounds, called the prefix system. It uses the same prefixes that we used to name hydrated compounds.

In the prefix system, the number of atoms of each element in the compound is indicated with a prefix. Because these rules are for binary compounds, the ending of the second element is changed to "ide". There are two additional rules:

1. If there is only one atom of the first element, then a prefix is not used for that element:
   eg. CO_2 is _____
   eg. NI_3 is _____

2. When the second element is oxygen and the prefix ends in an "o" or "a", then the "o" or "a" is omitted:
   eg. CO is _____
   P_2O_5 is _____
   N_2O is _____
   N_2O_4 is _____

Prefixes
mono means
di means
tri means
tetra means
penta means
hexa means
hepta means
octa means
nona means
deca means

1. Name the following covalent compounds using the prefix system:

SO_2	NF_3
$CC\ell_4$	N_2H_2
SO_3	P_2H_4
PF_5	XeF_6
$SC\ell_6$	$NC\ell_3$
N_2S_4	BI_3
PBr_3	SF_6
H_2O	SiO_2
NO_2	CS_2
OF_2	XeI_4

2. Use the prefix system to write the chemical formulas for the following molecules:

dihydrogen monoxide	silicon dioxide
dinitrogen trioxide	carbon monoxide
sulfur dioxide	sulfur tetrafluoride
boron triiodide	chlorine dioxide
carbon tetrachloride	phosphorus pentachloride
iodine heptafluoride	xenon hexafluoride
boron tribromide	silicon tetraiodide
diphosphorus pentasulfide	disulfur dichloride

Nomenclature #7: Final Practice

1. **Write the IUPAC formulas for each of the following compounds:**

copper (II) hydroxide pentahydrate	cobalt (II) carbonate
phosphorus trihydride	nitrous acid
gold (III) nitrite trihydrate	tin (IV) thiosulfate
nitric acid	carbon monoxide
phosphorus (V) chloride	lead (IV) dichromate
hydrosulfuric acid	carbon disulfide
mercury (I) hypobromite	nickel (II) fluoride
arsenic (III) oxide	diphosphorus tetrafluoride
liquid bromine	bromic acid
nickel (III) hypochlorite	antimony (V) iodite
sodium cyanide	hydrophosphoric acid
mercury (II) cyanate	silver peroxide
chloric acid	tin (II) permanganate
cesium fluoride	manganese (IV) hypobromite
arsenic (V) bromate	arsenic (III) oxide
silver thiocyanate	phosphorous acid
phosphoric acid	hydrofluoric acid
gold (I) oxalate	phosphorus tetrachloride
bismuth (III) iodite	potassium peroxide
nitrogen gas	phosphorus (III) carbide
antimony (V) hydroxide	hypobromous acid
cesium peroxide	perchloric acid
iodous acid	iron (III) bromite
lithium perchlorate	carbonic acid
iron (III) acetate	sodium bicarbonate
lead (IV) thiocyanate	hydroiodic acid
periodic acid	bismuth (V) hydrogen phosphite
dihydrogen monosulfide	acetic acid
cobalt (III) bromite	lead (II) periodate
copper (I) carbonate heptahydrate	
tin (IV) dichromate monohydrate	
iron (III) dihydrogen phosphite nonahydrate	
bismuth (V) bromate octahydrate	
lead (II) chromate tetrahydrate	

2. Write correct names for each of the following using the IUPAC method:

$CoCO_3$	$Sn(CrO_4)_2$
$PC\ell_3$	$Pb(Cr_2O_7)_2$
$Ni_2(Cr_2O_7)_3$	$Sb(IO_2)_3$
P_2O_3	CS_2
$HgSO_3$	$Fe(IO_4)_2$
NH_4BrO	Li_2O_2
$As(BrO_3)_5$	SnS_2O_3
$AuC\ell O$	As_2O_3
$Bi(IO_2)_3$	H_3PO_3
HIO_4	$Mn(OH)_4$
$CuHCO_3$	Na_2O_2
$Co(BrO_2)_3$	Au_3BO_3
$Ni_3(PO_3)_2$	$HgBrO_2$
$HgBr$	$Ba(CH_3COO)_2$
$HC\ell O$	F_2
$KHSO_4$	Ca_3N_2
$Pb_3(PO_3)_4$	$MgHPO_3$
$Zn(OH)_2$	SO_2
$Fe_2S_3 \cdot 3\ H_2O$	$HBrO_2$
NaH	$CC\ell_4$
$Ca(C\ell O)_2$	H_2O
H_2S	N_2
H_2SO_3	$Au_2C_2O_4$
BaO	SnF_4
$(NH_4)_3P$	HI
$PbCrO_4 \cdot 4\ H_2O$	$Bi(SCN)_3$
H_2SO_4	H_2O_2
H_3P	N_2O_4
Ag_2O_2	$Si(OCN)_4$
HIO	HCH_3COO
$Cu(OH)_2 \cdot 5\ H_2O$	
$Au(NO_2)_3 \cdot 3\ H_2O$	
$Na_2Cr_2O_7 \cdot 6\ H_2O$	
$Fe(H_2PO_3)_3 \cdot 9\ H_2O$	
$A\ell_2(HPO_4)_3 \cdot 2\ H_2O$	
$CuHCO_3 \cdot 7\ H_2O$	