BINARY COMPOUND DRILL SHEET

Binary Compounds containing only two types of elements. Always use the suffix “ide”. Except for binary acids, which we will study later.

1 Write the IUPAC chemical names for the following compounds

a) NaCl
b) K_2O
c) ZnS
d) MgO
e) $BeBr_2$
f) Al_2O_3
g) CaF_2
h) KBr
i) ZnI_2
j) LiCl
k) Ag_3N

2. Write the chemical formula of the following compounds

l) Potassium bromide
m) Sodium oxide
n) Calcium chloride
o) Potassium phosphide
p) Lithium iodide
q) Barium sulfide
r) Beryllium nitride
s) Rubidium fluoride
t) Sodium carbide
u) Potassium sulfide
v) Strontium hydride

BINARY COMPOUND DRILL SHEET

1 Write the IUPAC chemical name for the following: Stock System: (IUPAC) use a Roman Numeral to represent the oxidation number of the first element (metal) in a compound.

a) Cu_2O
b) Fe_3N_2
c) NiS
d) HgCl
e) SnO_2
f) PbI_4
g) CuF
h) SnH_2
i) $SnCl_4$
j) $CoBr_2$
k) CrF_3

1 Write the "IC" or "OUS" suffix chemical name of the following:
Note: The suffix "IC" is used for the higher oxidation number
The Suffix "OUS" is used for the lower oxidation number.

a) Fe_2S_3
b) NiN
c) $PbCl_2$
d) $HgCl_2$
e) SnS_2
f) PbI_4
g) CuF
h) SnH_2
i) Hg_4C
j) $CoBr_2$
k) AuF_3

Practice: Name each of the following. Where applicable, give both the Stock and "Ous - ic" names/

a) ZnS
b) Na_2O
c) FeP
d) Sb_2S_3
e) $FeCl_3$
f) Sb_2O_3
g) $CaCl_2$
h) BaO
i) $CuBr_2$
j) Hg_2O
k) $HgCl_2$
l) H_2O
m) PBr_3
n) P_2O_3
o) As_2O_3
p) As_2O_5
q) $SnCl_4$
r) SnO
s) MnO
t) MnO_2
u) PbO
v) PbO_2
w) $SbCl_5$
x) $SbCl_3$

Rules for working out oxidation numbers

1) All Group I elements have an oxidation number of +1
2) All Group II elements have an oxidation number of +2
3) Aluminum is always +3, Silver is always + 1
4) Fluorine is always -1
5) Oxygen's Oxidation number is always -2, except in peroxides (which contain an O – O linkage), and when combined with fluorine, (H_2O_2: oxygen = -1, in F_2O: oxygen = +2).
6) Hydrogen's oxidation number is always +1, except if it is combined with a metal, to form ionic metal hydrides, then it is -1
7) The sum of all Oxidation numbers in a molecule is equal to 0
8) The sum of all the Oxidation numbers in a polyatomic ion is the charge of the ion.

Assignment:

1.What is the oxidation number of nitrogen in each of the following:

a) N_2 (b) NO (c) N_2O (d) NO_3^{-1} (e) NO_2^{-1} (f) HNO_3 (g) $NaNO_3$ (h) Mg_3N_2

2. Calculate the oxidation numbers of the underlined elements in the following:

a) $H_3\underline{As}O_4$ (b) $H\underline{Cr}_2O_7$ (c) $Pb\underline{S}O_4$ (d) $Na_2\underline{S}_2O_3$ (e) $Na_8\underline{Ta}_6O_{19}$ (f) $\underline{N}H_4\underline{N}O_3$

Oxidation Number and the Stock Notation

Compounds with different oxidation numbers are distinguished in names by the use of oxidation numbers:

$FeCl_2$	iron (II) chloride	(preferred to the older name ferrous chloride)
$FeCl_3$	iron (III) chloride	(preferred to the older name ferric chloride)
$NaClO$	sodium chlorate (I)	(preferred to hypochlorite)
$NaClO_3$	sodium chlorate (V)	(preferred to chlorate)
$NaClO_4$	sodium chlorate (VII)	(preferred to perchlorate)

NOMENCLATURE: SIMPLE BINARY COMPOUNDS

1. Provide names for the following Binary Inorganic Compounds

a) KCl
b) ZnF_2
c) ZnO
d) KF
e) HBr
f) $Ba(OH)_2$
g) CCl_4
h) N_2O_5
i) H_2Se
j) LiI
k) PF_5
l) Na_3N
m) AgBr
n) HF
o) KrF_2
p) XeF_6
q) Na_4C
r) CO
s) I_2O_5
t) Cs_2S

2. Give the formula for the following

a) Xenon trioxide
b) Potassium nitride
c) Sodium oxide
d) Phosphorus pentabromide
e) Nitrogen trichloride
f) Selenium tetrafluoride
g) Potassium cyanide
h) Aluminum sulphide
i) Potassium phosphide
j) Trisulphur dinitride
k) Barium astatide
l) Radon tetraiodide
m) Radium bromide
n) Boron phosphide
o) Calcium hydroxide
p) Barium carbide
q) Cesium selenide
r) Sodium telluride
s) Magnesium nitride
t) Silver chloride

NOMENCLATURE PRACTICE

Write the correct chemical formula for each of the following names:

1) Calcium hydride
2) Calcium hydroxide
3) Hydrochloride acid
4) Hydrogen chloride
5) Copper (I) chloride
6) Copper (II)Chloride
7) Iron (III) Oxide
8) Iron (II) Oxide
9) Aluminum sulfate
10) Aluminum sulfite
11) Plumbous hydroxide
12) Plumbic hydroxide
13) Ferric carbonate
14) Ferrous carbonate
15) Zinc nitrite
16) Zinc nitrate
17) Nitric acid
18) Nitrous acid
19) Hydrogen cyanide
20) Hypochlorous acid
21) Perchloric acid
22) Silver acetate
23) Sodium acetate
24) Magnesium acetate
25) Potassium hydroxide
26) Ammonium fluoride
27) Ammonium hydroxide
28) Calcium sulfide
29) Calcium sulfate
30) Tin (IV)iodide
31) Tin (II) iodide
32) Aluminum nitride
33) Aluminum nitrate
34) Cuprous nitrate
35) Cupric nitrate
36) Cupric phosphate
37) Antimony (V) sulfide
38) Antimony (III) sulfide
39) Ammonium carbonate
40) Ammonium acetate

Write the Stock names for the following compounds:

1) $Al_2(SO_4)_3$
2) Na_2CO_3
3) $Ba(BrO_3)_2$
4) $CoSO_4$
5) Au_3PO_4
6) $H_2SO_{4\ (aq)}$
7) $CaSO_3$
8) $NaNO_2$
9) $CaCO_3$
10) $Mn(CO_3)_2$
11) $AgNO_3$
12) $Fe(ClO_3)_3$
13) $Cu_3(PO_4)_2$
14) $HgCO_3$
15) $Pb(ClO_4)_2$
16) $Zn_3(PO_4)_2$
17) $FeSO_4$
18) $AgBrO_4$
19) $Ca(NO_2)_2$
20) Cu_2CO_3
21) $CoCl_2$
22) $HClO_{2\ (aq)}$
23) NaIO

NOMENCLATURE: SIMPLE IONIC COMPOUNDS

Give the formula for the following compounds containing polyatomic ions:

1) Sodium nitrate

2) Zinc sulfate

3) Lead (II) chloride

4) Zinc carbonate

5) Aluminum sulfate

6) Tin (II) chloride

7) Iron (II) Sulfite

8) Antimony (III) chloride

9) Potassium nitrate

10) Sodium phosphate

11) Magnesium nitrate

12) Silver hypochlorite

13) Iron (II) carbonate

14) Ammonium phosphate

15) Iron (III) chromate

16) Ammonium carbonate

17) Lead (II) phosphate

18) Iron (II) Chlorite

19) Iron (II) Chromate

20) Nickel (II)acetate

21) Copper (II) acetate

22) Sodium chromate

23) Copper (II) Hydroxide

24) Lithium chromate

25) Copper (I) carbonate

26) Potassium permanganate

27) Nickel (II) nitrate

28) Silver perchlorate

29) Calcium chlorate

30) Potassium phosphate

31) Ammonium sulfite

32) Magnesium sulfate

33) Aluminum perchlorate

34) Ammonium dichromate

Review of Nomenclature

Write correct formulas of the compounds formed when the positive ions, cations, in the vertical column combine with the negative ions listed across the top row. The first two are done for you.

Cation	Nitrate	Sulphate	Carbonate	Phosphate	Hydroxide	Chromate	Perchlorate
Sodium	$NaNO_3$	Na_2SO_4					
Ammonium							
Mercury (I)							
Zinc							
Calcium							
Magnesium							
Copper (I)							
Lead (II)							
Aluminum							
Cupric							
Ferric							
Plumbic							
Stannic							
Arsenic (V)							
Aurous							
Manganese (IV)							
Cobalt (III)							
Stibinous							

Write correct formulas of the compounds formed when the positive ions, cations, in the vertical column combine with the negative ions listed across the top row. The first two are done for you.

Cation	Hydrogen carbonate	Dichromate	Acetate	Sulphide	Chloride	Sulphite	Cyanide
Sodium	$NaHCO_3$	$Na_2Cr_2O_7$					
Ammonium							
Mercury (I)							
Zinc							
Calcium							
Magnesium							
Copper (I)							
Lead (II)							
Aluminum							
Cupric							
Ferric							
Plumbic							
Stannous							
Arsenic (III)							
Auric							
Manganese (II)							
Barium							

NAMING COMPOUNDS: BINARY ACIDS & OXYACIDS

All acids produce hydrogen ions in aqueous solution. $H^+_{(aq)}$. Some acids are made by dissolving polar covalent gaseous molecules in water.

e.g.

$$HCl_{(g)} \longrightarrow HCl_{(aq)}$$

Hydrogen Chloride — Hydrochloric Acid

Usually acids have the subscript (aq) for AQUEOUS

FORMULA	NAME		FORMULA	NAME
$H_2SO_{4\ (aq)}$				Hydrobromic acid
$H_2SO_{3\ (aq)}$				Carbonic acid
$HNO_{3\ (aq)}$				Telluric acid
$HNO_{2\ (aq)}$				Hydrosulphuric acid
$HClO_{4\ (aq)}$				Chlorous acid
$HClO_{3}$ (aq)				Hydrochloric acid
$HClO_{2\ (aq)}$				Sulphuric acid
$HClO_{(aq)}$				*Acetic acid (Ethanoic acid)
$H_2CO_{3\ (aq)}$				Nitrous acid
$H_2S_{(aq)}$				Phosphorus acid
$H_3PO_{4\ (aq)}$				Sulphurous acid

THE OXY-ACIDS RADICALS AND THEIR COMPOUNDS

Write the formulae for the following:

Magnesium sulphate

Calcium carbonate

Sodium chlorate

Potassium nitrate

Aluminum phosphate

Sodium nitrite

Silver carbonate

Zinc sulphite

Calcium phosphite

Potassium perchlorate

Copper (II) nitrate

Calcium chlorite

Gold (III) sulphite

Iron (III) nitrite

Lead (II) phosphate

Lithium phosphate

Copper (I) chlorite

Auric nitrate

Silver carbonate

Plumbous perchlorate

Ammonium bromate

Stannic hypoiodite

Ferrous acetate

Potassium permanganate

Prefixes for molecular compounds

1= Mono	6= Hexa
2= Di	7= Hepta
3= Tri	8= Octa
4= Tetra	9= Ennea (nona)
5= Penta	10= Deca

IUPAC Rules for Naming Acids

			Examples	
Ionic Name	**Acid Name**	**Formula**	**Ionic Name**	**Acid Name**
Hydrogen –ide	Hydro –ic acid	HCl	Hydrogen chloride	Hydrochloric acid
Hydrogen –ate	ic acid	H_3PO_4	Hydrogen Phosphate	Phosphoric acid
Hydrogen –ite	Ous acid	H_3PO_3	Hydrogen phosphite	Phophorous acid

Molecular Compounds to be Memorized

Some molecular compounds have traditional names that do not conform to the IUPAC naming system. The manes and formulas for the following compounds need to be memorized.

NH_3	Ammonia
$C_6H_{12}O_6$	Glucose
$C_{12}H_{22}O_{11}$	Sucrose
CH_4	Methane
C_3H_8	Propane
CH_3COOH	Acetic acid (ethanoic acid)
H_2O	Water
O_3	Ozone
CH_3OH	Methanol
C_2H_5OH	Ethanol
H_2O_2	Hydrogen peroxide

The Following elements only exist in molecular form and their formulas also need to be memorized:

P_4 (s)	Phosphorous
S_8 (s)	Sulphur
H_2 (g)	Hydrogen gas
O_2 (g)	Oxygen gas
N_2 (g)	Nitrogen gas
F_2 (g)	Fluorine gas
Cl_2 (g)	Chlorine gas
Br_2 (l)	Bromine
I_2 (s)	Iodine

OXY-ACID FAMILIES AND THEIR RELATED COMPLEX IONS

From each of the Famous Five oxy-acids, a family of acids and complex ions may be derived and named using a simple set of rules. Some of the derivatives do not actually exist but that does not matter at this point in your study of chemistry.

Oxy-acid Formula	**Oxy-acid Name**	**Complex Ion**	**Complex Ions Names**
HNO_4	*Pernitric acid*	NO_4^-	*Pernitrate*
HNO_3	**Nitric acid**	**NO_3^-**	**Nitrate**
HNO_2	**Nitrous acid**	**NO_2^-**	**Nitrite**
HNO	*Hyponitrious acid*	NO^-	*Hyponitrite*
$HClO_4$	**Perchloric acid**	**ClO_4^-**	**Perchlorate**
$HClO_3$*	**Chloric acid**	**ClO_3^-**	**Chorate**
$HClO_2$	**Chlorous acid**	**ClO_2^-**	**Chlorite**
HClO	**Hypochlorous acid**	**ClO^-**	**Hypochlorite**
H_2CO_4	*Percarbonic acid*	CO_4^{2-}	*Percabonate*
H_2CO_3	**Cabonic acid**	**CO_3^{2-}**	**Cabonate**
H_2CO_2	*Carbonous acid*	CO_2^{2-}	*Carbonite*
H_2CO	*Hypocarbonous acid*	CO^{2-}	*Hypocarbonite*
H_2SO_5	*Persulphric acid*	SO_5^{2-}	*Persulfate*
H_2SO_4	**Sulfuric acid**	**SO_4^{2-}**	**Sulfate**
H_2SO_3	**Sulfurous acid**	**SO_3^{2-}**	**Sulfite**
H_2SO_2	*Hyposulfurous acid*	SO_2^{2-}	*Hyprcarbonite*
H_3PO_5	*Perphosphoric acid*	PO_5^{3-}	*Perphosphate*
H_3PO_4	**Phosphoric acid**	**PO_4^{3-}**	**Phosphate**
H_3PO_3	*Phosphorous acid*	PO_3^{3-}	*Phosphite*
H_3PO_2	*Hypophosphorous acid*	PO_2^{3-}	*Hypophosphite*

NOTE: The **parent** oxy-acid is in bold font in the left-hand column. The names of the oxy-acids and complex ions that **do** exist (according to the **Handbook of Chemistry and Physics**; Pg. B-70 in the 61th edition) are in bold font in the second and fourth columns.

* If you substitute any of the other halogens (fluorine, bromine or iodine) for chlorine in $HClO_3$, you produce HFO_3, fluoric acid, $HBrO_3$, bromic and HIO_3, iodic acid. Each of these also produces a family of acids similar to the family produced from $HClO_3$.

USES OF THE 'FAMOUS FIVE' OXY-ACIDS

1. Nitric Acid, HNO_3

Used in combination with hydrochloric acid as a solvent for gold and most other substances: 1 part HNO_3 to 3 parts HCl produces the solution known as "**aqua regia**".

Used to produce dyes, photographic materials, rocket fuels, drugs, fertilizers, plastics and metallic nitrate compounds.

Explosives such as dynamite, nitroglycerine, trinitrotoluene, (TNT), and ammonium nitrate are all manufactured from nitric acid.

2. Chloric Acid, $HClO_3$

This acid is violently explosive in pure, concentrated form, and is used to prepare salts such as potassium chlorate, $KClO_3$, and sodium chlorate, these are then used as oxidizing agents and bleaches in the manufacture of explosives and matches.

3. Carbonic Acid, H_2CO_3

Used to produce carbonate and bicarbonate salts such as sodium carbonate, Na_2CO_3, which is used in the glass industry and sodium bicarbonate, (aka: sodium hydrogen carbonate, $NaHCO_3$), which is commonly called baking soda.

Carbonic acid is found in carbonated drinks and acid rain:

$$CO_{2(g)} + H_2O_{(l)} \longrightarrow H_2CO_{3(aq)}$$

A carbonic acid and sodium carbonate in the blood produces a 'buffer'', (a substance than allows the pH to remain constant upon the addition of a small amount of acid or base), which keeps the blood pH at very close to 7.35; without this natural buffer, a small increase or decrease in blood pH would cause death.

4. Sulphuric Acid, H_2SO_4

Used as a solvent and as a dehydrating agent, also used to catalyse reactions, example:

$$HCOOH_{(l)} \xrightarrow{H_2SO_{4(l)}} H_2O_{(l)} + CO_{(g)}$$

Used in the production of steel and in petroleum industry, in the paper and pulp mills, uranium processing, and in the production of fertilizers such as ammonium sulphate, $(NH_4)_2SO_4$. It is also a component of acid rain: $H_2O_{(l)} + SO_{3(g)} \longrightarrow H_2SO_{4(aq)}$

5. Phosphoric Acid, H_3PO_4

Used in cola beverages to add a tart taste, used in the synthesis of food additives, fertilizers, detergents such as trisodium phosphate, TSP, Na_3PO_4, and to make salts such as calcium phosphate, $Ca_3(PO_4)_2$, used in water softeners.

Hydrated Salts

Many crystalline substances have a definite proportion of water in their formula which may be removed by heating, after which the crystalline form disappears and the substance is changed to the amorphous powder. The water molecules are attached to each salt molecule in a specific ratio. In hydrated compounds, at the end of the chemical formula for the salt, a dot followed by the number of water molecules attached is shown:

$CoCl_2 \cdot 6H_2O_{(s)}$. The compound is named by writing the regular name of the salt followed by a prefix indicating the number of water molecules present, followed by the word 'hydrate'. Thus, $CoCl_2 \cdot 6H_2O_{(s)}$ is called cobalt (II) chloride hexahydrate. Greek prefixes are used to indicate the number of molecules of water of crystallisation.

Hydration is the process by which certain substances absorb a definite proportion of water into their crystal structure.

Water of hydration is water which has been incorporated into the crystal structure of certain salts, the loss of this destroys the crystalline form:

$$CoCl_2 \cdot 6H_2O_{(s)} \xrightarrow{?} CoCl_{2(s)} + 6\ H_2O_{(g)}$$

cobalt (II) chloride hexahydrate — cobalt (II) chloride

hydrated, pink — **anhydrous, blue**

Name each of the following hydrates:

$K_2Cr_2O_7.2\ H_2O$

$NiSO_4.7H_2O$

$Be(NO_2)_2 \cdot 3H_2O$

$FeSO_4.4H_2O$

Write the formula for each of the following hydrated compounds:

iron (II) phosphate octahydrate

sodium chromate decahydrate

magnesium permanganate hexahydrate

iron (III) sulphate nonahydrate