

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) Na₂O
- c) FeP
- d) Sb₂S₃
- e) FeCl₃
- f) Sb₂O₃
- g) CaCl₂
- h) BaO
- i) CuBr₂
- j) Hg₂O
- k) HgCl₂
- l) H₂O
- m) PBr₃
- n) P₂O₃
- o) As₂O₃
- p) As₂O₅
- q) SnCl₄
- r) SnO
- s) MnO
- t) MnO₂
- u) PbO
- v) PbO₂
- w) SbCl₅
- x) SbCl₃

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, (H₂O₂: oxygen = -1, in F₂O: 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) N₂ (b) NO (c) N₂O (d) NO₃⁻¹ (e) NO₂⁻¹ (f) HNO₃ (g) NaNO₃ (h) Mg₃N₂

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

- a) H₃AsO₄ (b) HCr₂O₇ (c) PbSO₄ (d) Na₂S₂O₃ (e) Na₈Ta₆O₁₉ (f) NH₄NO₃

Oxidation Number and the Stock Notation

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

FeCl₂ iron (II) chloride (preferred to the older name ferrous chloride)
 FeCl₃ iron (III) chloride (preferred to the older name ferric chloride)

NaClO sodium chlorate (I) (preferred to hypochlorite)
 NaClO₃ sodium chlorate (V) (preferred to chlorate)
 NaClO₄ 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

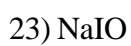
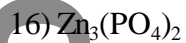
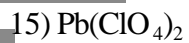
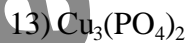
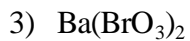
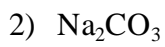
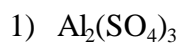
NOMENCLATURE PRACTICE

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

- 1) Calcium hydride
- 2) Calcium hydroxide
- 3) Hydrochloric 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

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Write the Stock names for the following compounds:



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 ₂ SO ₄					
Ammonium							
Mercury (I)							
Zinc							
Calcium							
Magnesium							
Copper (I)							
Lead (II)							
Aluminum							
Cupric							
Ferric							
Plumbic							
Stannic							
Arsenic (V)							
Aurous							
Manganese (IV)							
Cobalt (III)							
Stibinous							

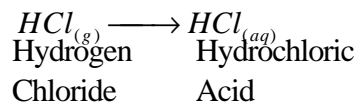
Write correct formulas of the compounds formed when the positive ions, cations, in the vertical column combine with the negative ions listed across the top row. The first two are done for you.

Cation	Hydrogen carbonate	Dichromate	Acetate	Sulphide	Chloride	Sulphite	Cyanide
Sodium	NaHCO ₃	Na ₂ Cr ₂ O ₇					
Ammonium							
Mercury (I)							
Zinc							
Calcium							
Magnesium							
Copper (I)							
Lead (II)							
Aluminium							
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.



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 ₃ PO ₄	Hydrogen Phosphate	Phosphoric acid
Hydrogen -ite	Ous acid	H ₃ PO ₃	Hydrogen phosphite	Phosphorous acid

Molecular Compounds to be Memorized

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

NH ₃	Ammonia
C ₆ H ₁₂ O ₆	Glucose
C ₁₂ H ₂₂ O ₁₁	Sucrose
CH ₄	Methane
C ₃ H ₈	Propane
CH ₃ COOH	Acetic acid (ethanoic acid)
H ₂ O	Water
O ₃	Ozone
CH ₃ OH	Methanol
C ₂ H ₅ OH	Ethanol
H ₂ O 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	<i>Pernitric acid</i>	NO ₄ ⁻	<i>Pernitrate</i>
HNO₃	Nitric acid	NO₃⁻	Nitrate
HNO ₂	Nitrous acid	NO ₂ ⁻	Nitrite
HNO	<i>Hyponitric acid</i>	NO ⁻	<i>Hyponitrite</i>
HClO ₄	Perchloric acid	ClO₄⁻	Perchlorate
HClO₃*	Chloric acid	ClO₃⁻	Chorate
HClO ₂	Chlorous acid	ClO ₂ ⁻	Chlorite
HClO	Hypochlorous acid	ClO ⁻	Hypochlorite
H ₂ CO ₄	<i>Percarbonic acid</i>	CO ₄ ²⁻	<i>Percarbonate</i>
H₂CO₃	Cabonic acid	CO₃²⁻	Cabonate
H ₂ CO ₂	<i>Carbonous acid</i>	CO ₂ ²⁻	<i>Carbonite</i>
H ₂ CO	<i>Hypocarbonous acid</i>	CO ²⁻	<i>Hypocarbonite</i>
H ₂ SO ₅	<i>Persulphric acid</i>	SO ₅ ²⁻	<i>Persulfate</i>
H₂SO₄	Sulfuric acid	SO₄²⁻	Sulfate
H ₂ SO ₃	Sulfurous acid	SO ₃ ²⁻	Sulfite
H ₂ SO ₂	<i>Hyposulfurous acid</i>	SO ₂ ²⁻	<i>Hyprcarbonite</i>
H ₃ PO ₅	<i>Perphosphoric acid</i>	PO ₅ ³⁻	<i>Perphosphate</i>
H₃PO₄	Phosphoric acid	PO₄³⁻	Phosphate
H ₃ PO ₃	<i>Phosphorous acid</i>	PO ₃ ³⁻	<i>Phosphite</i>
H ₃ PO ₂	<i>Hypophosphorous acid</i>	PO ₂ ³⁻	<i>Hypophosphite</i>

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 HClO₃, you produce HFO₃, fluoric acid, HBrO₃, bromic and HIO₃, iodic acid. Each of these also produces a family of acids similar to the family produced from HClO₃.

USES OF THE 'FAMOUS FIVE' OXY-ACIDS

1. Nitric Acid, HNO₃

Used in combination with hydrochloric acid as a solvent for gold and most other substances: 1 part HNO₃ 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.

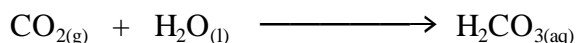
2. Chloric Acid, HClO₃

This acid is violently explosive in pure, concentrated form, and is used to prepare salts such as potassium chlorate, KClO₃, and sodium chlorate, these are then used as oxidizing agents and bleaches in the manufacture of explosives and matches.

3. Carbonic Acid, H₂CO₃

Used to produce carbonate and bicarbonate salts such as sodium carbonate, Na₂CO₃, which is used in the glass industry and sodium bicarbonate, (aka: sodium hydrogen carbonate, NaHCO₃), which is commonly called baking soda.

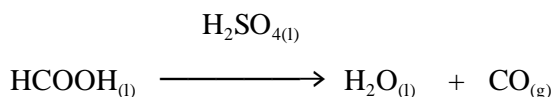
Carbonic acid is found in carbonated drinks and acid rain:



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, H₂SO₄

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



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, (NH₄)₂SO₄. It is also a component of acid rain: $\text{H}_2\text{O}_{(l)} + \text{SO}_{3(g)} \longrightarrow \text{H}_2\text{SO}_{4(aq)}$

5. Phosphoric Acid, H₃PO₄

Used in cola beverages to add a tart taste, used in the synthesis of food additives, fertilizers, detergents such as trisodium phosphate, TSP, Na₃PO₄, and to make salts such as calcium phosphate, Ca₃(PO₄)₂, used in water softeners.

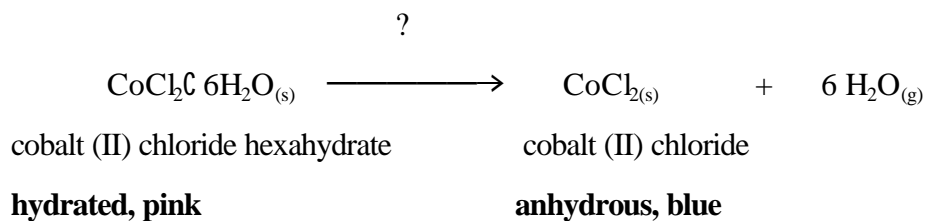
Hydrated Salts

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:

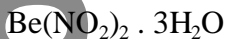
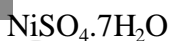
$\text{CoCl}_2 \cdot 6\text{H}_2\text{O}_{(s)}$. The compound is named by writing the regular name of the salt followed by a prefix indicating the number of water molecules present, followed by the word 'hydrate'. Thus, $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}_{(s)}$ is called cobalt (II) chloride hexahydrate. 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:



Name each of the following hydrates:



Write the formula for each of the following hydrated compounds:

iron (II) phosphate octahydrate

sodium chromate decahydrate

magnesium permanganate hexahydrate

iron (III) sulphate nonahydrate