Inorganic Compounds Nomenclature (Year 8 & 9)

1. Formulation and nomenclature of inorganic compounds

(nomenclature is de systematic approach to naming chemical compounds)

There are two different ways to name inorganic compounds: systematic or stoichiometric, and Stock or common nomenclature.

- The systematic nomenclature indicates the number of atoms of each element in the formula by using Greek prefixes.(1-mono, 2-di, 3-tri, 4-tetra, 5-penta, 6-hexa, 7-hepta, 8-octa, 9-nona, 10-deca). The systematic nomenclature is often used to name binary compounds, but hardly used in any other cases.

- The Stock or common nomenclature uses accepted names for the anions and indicates the oxidation state of the metal with roman numbers in parentheses. It is very simple and frequently used.

To work out the formula, simply identify the cation and anion and calculate the adequate sub index to get an overall zero charge for the compound.

1.1. Ions

Cations are named with the name of the element followed by the charge in parentheses:

Fe^{2+}: iron (2+)
Na^{+}: sodium (1+)

Anions are named with the –ide ending followed by the charge in parentheses, although this one can be omitted if there is no ambiguity:

Cl^{-}: chloride
S^{2-}: sulfide

1.2. Metallic hydrides

These are combinations of a metallic cation with the hydride anion (H^{-}).

Common accepted nomenclature: *metal name*(oxidation state in romans) hydride; if the metal has only one oxidation state, it is omitted.

Stoichiometric nomenclature: *metal name* prefix-hydride; if the metal has only one oxidation state prefixes can be avoided, and often mono- prefix too.

Examples:

LiH	lithium hydride	lithium hydride
PdH_2	palladium(II) hydride	palladium dihydride
FeH_3	iron(III) hydride	iron trihydride

1.3. Non-metallic hydrides

These are combinations of non-metal simple anions with the H^{+} ion.

There are two kind of non-metallic hydrides. The ones of the groups 13, 14, 15 and O have their own names that you have to know:

B_2H_6	borane
CH_4	methane
NH_3	ammonia

Hydrides of the other non-metals are gases that, when dissolved in water, have acid character and can be named with the prefix hydro- connected to the stem of the non-metal with an –ic suffix and ending with the word acid. When referring to the gases, then they are named with the word hydrogen followed by the name of the non-metal ended with the prefix –ide:

H_2S	hydrosulfuric acid	hydrogen sulfide
H_2Se	hydroselenic acid	hydrogen selenide
HF	hydrofluoric acid	hydrogen fluoride
HCl	hydrochloric acid	hydrogen chloride
HBr	hydrobromic acid	hydrogen bromide
HI	hydriodic acid	hydrogen iodide
	(note the –o- of prefix dropped)	

1.4. Metallic oxides

These are combinations of the oxide anion (O^{2-}) with metallic cations. They have basic character, and, when reacted with water, produce hydroxides.

Their nomenclature is the same that for metallic hydrides, changing the word hydride for oxide:

FeO	iron(II) oxide	iron monoxide
Fe_2O_3	iron(III) oxide	diiron trioxide
Al_2O_3	aluminium oxide	aluminium oxide
Cu_2O	copper(I) oxide	dicopper monoxide

1.5. Non-metallic oxides

These are combinations of the oxide anion (O^{2-}) with non-metals, acting with some of their positive oxidation states. They have acid character, and, when reacted with water, produce oxyacids. They are formulated in the same way as the metallic oxides, and their nomenclature is also the same:

Cl_2O	chlorine(I) oxide	dichlorine monoxide
Cl_2O_3	chlorine(III) oxide	dichlorine trioxide
Cl_2O_5	chlorine(V) oxide	dichlorine pentoxide
Cl_2O_7	chlorine(VII) oxide	dichlorine heptoxide
SO_3	sulfur(VI) oxide	sulfur trioxide
SO_2	sulfur(IV) oxide	sulfur dioxide

There are two metals that present a dual behavior, being able to act both as metals and non-metals; these are chromium and manganese. When chromium acts with the oxidations state +6 and manganese with +6 and +7, their oxides have acid character and produce oxyacids and anions like chromate or permanganate.

1.6. Binary salts

Binary salts have a metallic cation and a simple non-metallic anion. They are named writing the name of the cation followed by the one of the anion.

NaCl	sodium chloride	sodium chloride
FeS	iron(II) sulfide	iron monosulfide
CoI_3	cobalt(III) iodide	cobalt triiodide
NiN	nickel(III) nitride	nickel mononitride

Li_2Se	lithium selenide	lithium selenide

1.7. Hydroxides

In the hydroxides, a metallic cation is combined with the hydroxide group, OH^-, which formally acts on the whole with the oxidation state –1. They are named like the metallic oxides, changing oxide for hydroxide:

NaOH	sodium hydroxide	sodium hydroxide
$Sn(OH)_2$	tin(II) hydroxide	tin dihydroxide
$Mn(OH)_3$	manganese(III) hydroxide	manganese trihydroxide

1.8. Oxyacids

Oxyacids are formed by the reaction of water with non-metallic oxides. They are formulated adding to the corresponding anion the ions H^+ needed to get a zero charge. They are named by changing the anion endings –ite and –ate by –ous and –ic respectively and adding the word acid:

HClO	hypochlorous acid
$HClO_2$	chlorous acid
$HClO_3$	chloric acid
$HClO_4$	perchloric acid
H_2CO_3	carbonic acid
H_2SO_3	sulfurous acid
H_2SO_4	sulfuric acid
HIO_4	periodic acid
H_3PO_4	phosphoric acid
H_2CrO_4	chromic acid
$H_2Cr_2O_7$	dichromic acid

1.9. Salts

Salts are formulated combining the ions that form them adequately. They are named following the same rules than for binary salts:

$BrO_3^- + Au^+ = AuBrO_3$	gold(I) bromate
$MnO_4^- + K^+ = KMnO_4$	potassium permanganate

2. Exercises

1. $ZnSO_3$
2. SrO
3. Hg_2CO_3
4. NO_2
5. KBr
6. CuOH
7. PdH_2
8. HIO
9. K_2MnO_4
10. $Au_2(CrO_4)_3$
11. KIO_4
12. $HBrO_3$
13. Co_2O_3
14. Ag_2O
15. $Pb(OH)_2$
16. H_2Se
17. H_2S
18. $Ni(OH)_2$
19. $BaSO_3$
20. mercury(II) sulfide
21. zinc dichromate
22. ammonia
23. nitrous acid
24. phosphorus(III) iodide
25. copper(I) hydroxide
26. lead(II) iodate
27. iron(III) fluoride
28. gold(III) hydroxide
29. sodium hypochlorite
30. zinc chromate

31. nickel(II) nitrate
32. rubidium hydride
33. sulfurous acid
34. borane
35. methane
36. tin(II) chlorate
37. aluminium trichloride
38. nickel(III) iodide
39. nitrogen(III) oxide
40. cobalt(II) oxide
41. lead(IV) sulfide
42. sodium manganate