Chemical Nomenclature

What's in a name?

1

What's in a name?

- Quite a lot. The name gives us the information we need to determine what the compound is.
- Two naming systems:
  - One for ionic compounds (metals with non-metals)
  - One for covalent compounds (non-metals with non-metals)
- Another system governs the naming of organic compounds (those comprised mainly of carbon and hydrogen)

2

Naming ionic compounds

- The name of ionic compounds consists of two parts, the name of the cation and the name of the anion.
- The cation is always named first.
- Example: NaCl
  Sodium Chloride
  Cation name Anion Name

3

Naming ionic compounds

- The names of metal ions are same as the metals. But there are two kinds of metal ions: Type I and Type II
  - Type I metals form only one kind of ion. These are: Groups IA and IIA, Al, Ga, Zn, Cd, and Ag. Their charges are equal to their group number.
  - Type II metals form more than one kind of ion. For our purposes, if it's not Type I it's Type II. Their name contains a Roman numeral to specify the charge on the ion.

4

Naming ionic compounds

- The names of non-metal ions consist of the root of the non-metal name with the –ide ending.
  - O^{2-} is ***Ox***ide, N^{3-} is ***Nitr***ide
- The name of the compound gives us the formula. For example: Lithium Oxide
  - We know that there is a lithium ion (Li^+) and an oxide ion (O^{2-})

5

- The name of the compound gives us the formula. For example: Lithium Oxide
  - We know that there is a lithium ion (Li^+) and an oxide ion (O^{2-})
  - The charges give us the ratio of the ions in the compound. How is that? We can use the cross-over method:

    $Li^{+} \quad O^{2-}$

  - The charges are crossed-over and this gives us the formula Li_2O. "1"s are never explicitly written.

6

More on Type II metals

- Iron is a type two metal; it forms Fe^{2+} and Fe^{3+} ions.
- The Fe^{2+} is called Iron(II) ion. It used to be called Ferrous ion. The newer naming system gives us the charge without having to memorize it.
- The Fe^{3+} is called Iron(III) ion and used to be called Ferric ion.
- The thing to remember is that the number in parenthesis is the charge, ***NOT*** the number of that kind of atom in the compound!

•7

Older names vs. Newer names

- Older names are based on the Latin form of the name:
  Fe: Ferrum
  Cu: Cuprum
  Au: Aurum
  Ag: Argentum
- Charge had to be memorized based on the ending of the name (-ous was the lower charge)
- Based on current name of the element
- Name gives the charge as a Roman numeral

•8

How do we get the charges on Type II metals?

- Reverse the cross-over method.
- Example: Mn_3P_2

Mn_3P_2

•9

How do we get the charges on Type II metals?

- Reverse the cross-over method.
- Example: Mn_3P_2

$Mn_{\cancel{3}}P_{\cancel{2}}$

- We know that Phosphide has a 3- charge, it's in group VA. This means that the Manganese ion must have a 2+ charge, Manganese(II) Phosphide. If there are no subscripts, the charges on both have equal magnitude but opposite sign.

•10

Practice, Practice, Practice!

- $FeCl_3$
- Ni_3P_2
- RhO
- Cr_2O_3
- Li_2O
- Al_2S_3
- Ca_3N_2
- RbBr

•11

Practice Makes Perfect!

- Iron(III) Oxide
- Copper(I) Nitride
- Chromium(II) Iodide
- Gold(III) Chloride
- Sodium Sulfide
- Silver Bromide
- Aluminum Oxide
- Barium Fluoride

•12

Polyatomic ions

- List in textbook must be memorized. (Names, formulas and charges)
- Most of them are anions, only one is a cation that appears in compounds.
- The other cation is only in aqueous solution.
- A couple contain metals

13

Patterns in the polyatomic ions

- Some come in pairs, the only difference being one oxygen atom
  - o SO_3^{2-} , SO_4^{2-}
- The one with the least amount of oxygen end in –ite. One more oxygen end in –ate.
- One less oxygen than –ite is hypo-*root*-ite.
- One more oxygen than –ate is per-*root*-ate.
- Replacing an oxygen with a sulfur results in the prefix thio- being added.

14

Examples

SO_4^{2-}	Sulf***ate***	ClO^-	***Hypo***chlor***ite***
SO_3^{2-}	Sulf***ite***	ClO_2^-	Chlor***ite***
NO_2^-	Nitr***ite***	ClO_3^-	Chlor***ate***
NO_3^-	Nitr***ate***	ClO_4^-	***Per***chlor***ate***
SO_4^{2-}	Sulfate	$S_2O_3^{2-}$	***Thio***sulfate

15

Naming ionic compounds (reprise)

- Naming ionic compounds that contain polyatomic ions is no different than naming regular ionic compounds.
- Example: $Fe(C_2H_3O_2)_2$
  - o Iron(II) Acetate (or Ferrous acetate)

16

More Practice!

- Iron(II) Nitrite
- $AlCl_3$
- $(NH_4)_2CrO_4$
- Lithium Bicarbonate
- Osmium(III) Sulfate
- Calcium Oxalate
- Na_3PO_4
- $Mo(SO_3)_2$

17

Naming Covalent compounds

- Not as involved.
- Names are more descriptive of the formula
- Must memorize the list of prefixes
- Needed to distinguish between the multitude of compounds between different non-metals
- We will only name binary covalent compounds (those containing only 2 elements)

18

Prefixes

- 1: mono
- 2: di
- 3: tri
- 4: tetra
- 5: penta
- 6: hexa
- 7: hepta
- 8: octa
- 9: nona
- 10: deca

19

Rules for using prefixes

- Mono prefix is never used with the first element.
- If the prefix ends with the same ***sound*** as the beginning of the element, the end of the prefix is dropped.
- Like ionic compounds, the second element is named with the root of the element name with the appropriate prefix and the –ide suffix.
- Compounds containing hydrogen are named as if they are ionic.

20

Examples

- NO_2
  - Nitrogen Dioxide
- SO_3
  - Sulfur Trioxide
- P_2O_5
  - Diphosphorus Pentoxide
- H_2S
  - Hydrogen Sulfide
- HBr
  - Hydrogen Bromide

21

Exceptions

- H_2O is water not Dihydrogen Monoxide
- NH_3 is Ammonia not Nitrogen Trihydride
- Compounds containing mainly Carbon and Hydrogen are named under separate rules.

22

Acids

- Compounds containing Hydrogen, but not always.
- The formula is always written with the acidic hydrogens first. Examples:
  - HCl (1 acidic hydrogen)
  - H_2SO_4 (2 acidic hydrogens)
  - $HC_2H_3O_2$ (1 acidic hydrogen, 3 non-acidic)
- These are also almost always aqueous compounds.

23

Naming acids

- Two kinds of acids:
  - Binary acids, Hydrogen and one other element
  - Oxygen containing acids, Hydrogen and a polyatomic ion
- Binary acids (only a few):
  - HCl Hydrochloric acid
  - HF Hydrofluoric acid
  - HBr Hydrobromic acid
  - HI Hydriodic acid
  - H_2S Hydrosulfuric acid

24

Naming Oxygen containing acids

- Look at the ending of the polyatomic ion present:
  - If the ion ends in –ate, the acid will end with –ic.
  - If the ion ends in –ite, the acid will end with –ous.
- There is ***NO*** hydro- prefix.

25

Examples

- H_2SO_4 Sulfuric acid
- $HC_2H_3O_2$ Acetic acid
- HNO_2 Nitrous acid
- H_3PO_3 Phosphorous acid

26

Naming Practice

Practice makes perfect

27

Ionic compounds

- Cesium Phosphide
- $CoCl_2$
- Vanadium(III) Cyanate
- AlN
- Cadmium Hydroxide
- Li_3PO_4
- Ruthenium(II) Iodide
- $Cu_3(PO_4)_2$

28

Covalent Compounds

- NH_3
- Dinitrogen Tetroxide
- S_2P_4
- Hydrogen Sulfide
- CO_2
- Trisulfur Pentabromide
- IBr_3
- Boron Trifluoride

29

Acids

- Hydrosulfuric acid
- H_2CrO_4
- Oxalic acid
- HNO_2
- Sulfurous Acid
- HI
- Cyanic acid
- H_2CO_3

30

A Little of Each

- Nickel(II) Phosphate
- Perchloric acid
- Tetrasulfur Dioxide
- Sodium Iodide
- $H_2SO_4(aq)$
- Li_2CO_3
- N_2O_4
- $Cr_2(C_2O_4)_3$

31