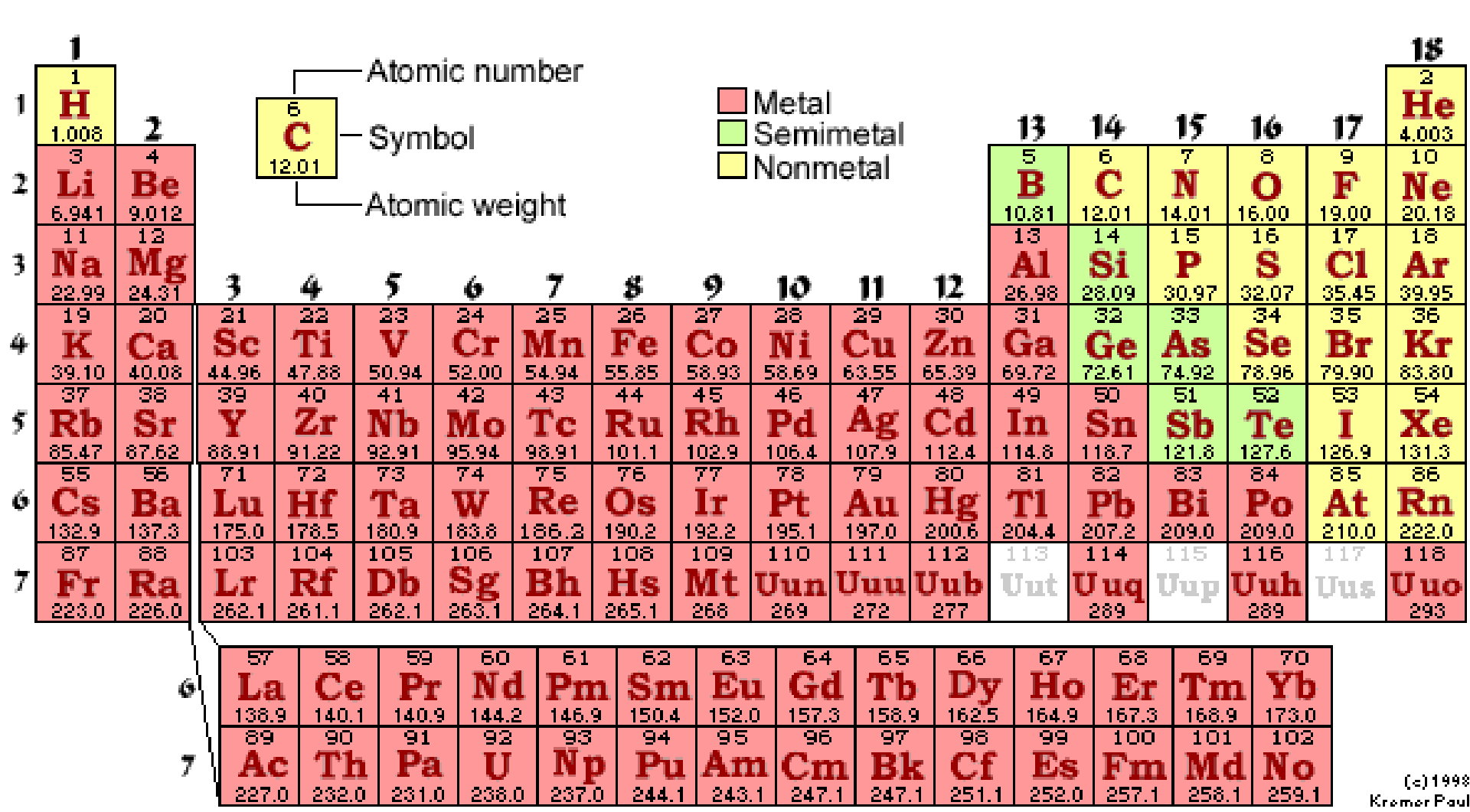
Chemical Nomenclature of Inorganic Compounds-Part 2

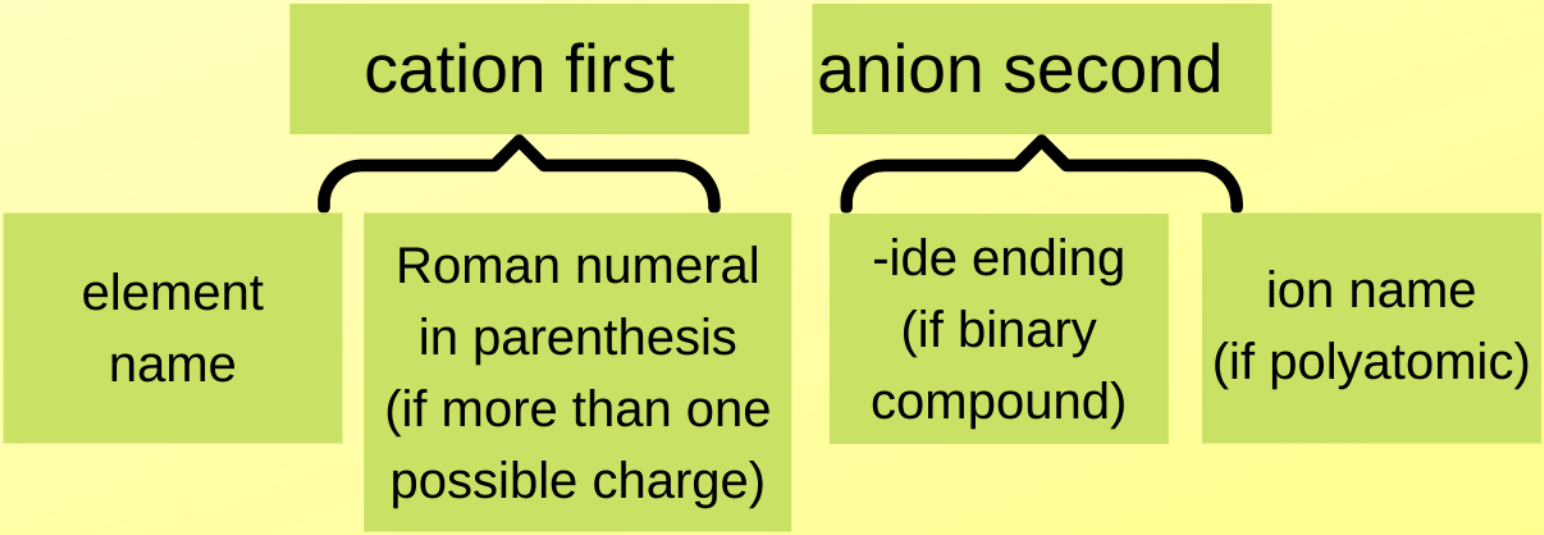
Table 3.6: Some common, simple and polyatomic ions

Vale-ncy	Name of ion	Symbol	Non-metallic element	Symbol	Polyatomic ions	Symbol
1.	Sodium	Na^+	Hydrogen	H^+	Ammonium	NH_4^+
	Potassium	K^+	Hydride	H^-	Hydroxide	OH^-
	Silver	Ag^+	Chloride	Cl^-	Nitrate	NO_3^-
	Copper (I)*	Cu^+	Bromide	Br^-	Hydrogen	
			Iodide	I^-	carbonate	HCO_3^-
2.	Magnesium	Mg^{2+}	Oxide	O^{2-}	Carbonate	CO_3^{2-}
	Calcium	Ca^{2+}	Sulphide	S^{2-}	Sulphite	SO_3^{2-}
	Zinc	Zn^{2+}			Sulphate	SO_4^{2-}
	Iron (II)*	Fe^{2+}				
	Copper (II)*	Cu^{2+}				
3.	Aluminium	Al^{3+}	Nitride	N^{3-}	Phosphate	PO_4^{3-}
	Iron (III)*	Fe^{3+}				

* *Some elements show more than one valency. A Roman numeral shows their valency in a bracket.*


Atomic number
Symbol
Atomic weight
Metal
Semimetal
Nonmetal
1
18
13
14
15
16
17
1 H 1.008
2 He 4.003
3 Li 6.941
4 Be 9.012
5 B 10.81
6 C 12.01
7 N 14.01
8 O 16.00
9 F 19.00
10 Ne 20.18
11 Na 22.99
12 Mg 24.31
3
4
5
6
7
8
9
10
11
12
13 Al 26.98
14 Si 28.09
15 P 30.97
16 S 32.07
17 Cl 35.45
18 Ar 39.95
19 K 39.10
20 Ca 40.08
21 Sc 44.96
22 Ti 47.88
23 V 50.94
24 Cr 52.00
25 Mn 54.94
26 Fe 55.85
27 Co 58.93
28 Ni 58.69
29 Cu 63.55
30 Zn 65.39
31 Ga 69.72
32 Ge 72.61
33 As 74.92
34 Se 78.96
35 Br 79.90
36 Kr 83.80
37 Rb 85.47
38 Sr 87.62
39 Y 88.91
40 Zr 91.22
41 Nb 92.91
42 Mo 95.94
43 Tc 98.91
44 Ru 101.1
45 Rh 102.9
46 Pd 106.4
47 Ag 107.9
48 Cd 112.4
49 In 114.8
50 Sn 118.7
51 Sb 121.8
52 Te 127.6
53 I 126.9
54 Xe 131.3
55 Cs 132.9
56 Ba 137.3
71 Lu 175.0
72 Hf 178.5
73 Ta 180.9
74 W 183.8
75 Re 186.2
76 Os 190.2
77 Ir 192.2
78 Pt 195.1
79 Au 197.0
80 Hg 200.6
81 Tl 204.4
82 Pb 207.2
83 Bi 209.0
84 Po 209.0
85 At 210.0
86 Rn 222.0
87 Fr 223.0
88 Ra 226.0
103 Lr 262.1
104 Rf 261.1
105 Db 262.1
106 Sg 263.1
107 Bh 264.1
108 Hs 265.1
109 Mt 268
110 Uun 269
111 Uuu 272
112 Uub 277
113 Uut
114 Uuq 289
115 Uup
116 Uuh 289
117 Uus
118 Uuo 293
6
7
57 La 138.9
58 Ce 140.1
59 Pr 140.9
60 Nd 144.2
61 Pm 146.9
62 Sm 150.4
63 Eu 152.0
64 Gd 157.3
65 Tb 158.9
66 Dy 162.5
67 Ho 164.9
68 Er 167.3
69 Tm 168.9
70 Yb 173.0
89 Ac 227.0
90 Th 232.0
91 Pa 231.0
92 U 238.0
93 Np 237.0
94 Pu 244.1
95 Am 243.1
96 Cm 247.1
97 Bk 247.1
98 Cf 251.1
99 Es 252.0
100 Fm 257.1
101 Md 258.1
102 No 259.1
(c)1998
Kremer Paul

Naming Ionic Compounds



$SrCl_2$	strontium chloride
$CoCl_2$	cobalt(II) chloride
$Pt_3(AsO_2)_4$	platinum(II) arsenate

Naming Oxides of C, S, N, P

Greek prefixes are used to denote the number of atoms of each element present.

TABLE 5.5 Greek Prefixes

Prefix	Meaning	Prefix	Meaning
Mono–	1	Hexa–	6
Di–	2	Hepta–	7
Tri–	3	Octa–	8
Tetra–	4	Nona–	9
Penta–	5	Deca–	10

Naming Oxides of C, S, N, P

TABLE 5.6 Some Compounds Named Using Greek Prefixes

Compound	Name	Compound	Name
CO	Carbon monoxide	SO_3	Sulfur trioxide
CO_2	Carbon dioxide	NO_2	Nitrogen dioxide
SO_2	Sulfur dioxide	N_2O_5	Dinitrogen pentoxide

The prefix *mono-* is generally omitted for the first element.

For ease of pronunciation, we usually eliminate the last letter of a prefix that ends in “o” or “a” when naming an oxide.

Example: N_2O_5 is *dinitrogen pentoxide* not *dinitrogen pentaoxide*

Another Example: MnO_2

Name the first ion. Since it is a transition metal, you must use a Roman Numeral.

How do you determine the Roman Numeral?

Manganese IV oxide

It is the same as the charge.

What is the charge of Mn?

All compounds are neutral.

Oxygen has a “-2” charge.

There are two oxygens and one Mn.

Therefore Mn must have a +4 charge for this compound to be neutral.

Names and charges of some important Ionic Species

TABLE 5.10 Common Polyatomic Ions

Name	Formula/Charge
Cations	
ammonium	NH_4^+
hydronium	H_3O^+
mercury(I)	Hg_2^{2+}
Anions	
acetate	$C_2H_3O_2^-$
azide	N_3^-
carbonate	CO_3^{2-}
chlorate	ClO_3^-
chlorite	ClO_2^-
chromate	CrO_4^{2-}
cyanide	CN^-
dichromate	$Cr_2O_7^{2-}$
dihydrogen phosphate	$H_2PO_4^-$
hydrogen carbonate or bicarbonate	HCO_3^-
hydrogen phosphate	HPO_4^{2-}
hydrogen sulfate or bisulfate	HSO_4^-

Names and formulas of important Anionic Species

TABLE 5.10 Common Polyatomic Ions

Name	Formula/Charge
hydroxide	OH^-
hypochlorite	ClO^-
nitrate	NO_3^-
nitrite	NO_2^-
oxalate	$C_2O_4^{2-}$
perchlorate	ClO_4^-
permanganate	MnO_4^-
peroxide	O_2^{2-}
phosphate	PO_4^{3-}
phosphite	PO_3^{3-}
sulfate	SO_4^{2-}
sulfite	SO_3^{2-}
thiocyanate	SCN^-

Cu_2S

Copper I Sulfide

Name the first ion. Since it is a transition metal, you must use a Roman Numeral.

Which Roman Numeral? The Roman Numeral is the same as the charge of the ion.

How do you find the charge?

Deductive reasoning!

All compounds are neutral

Sulfur has a -2 charge (group 16)

There are two coppers.

Therefore each copper must have a +1 charge for all ions to be neutral

Familiar Inorganic Compounds

TABLE 5.11 Common and Systematic Names of Some Familiar Inorganic Compounds

Formula	Common name	Systematic name
H_2O	Water	Dihydrogen monoxide
NH_3	Ammonia	Trihydrogen nitride
CO_2	Dry ice	Solid carbon dioxide
NaCl	Salt	Sodium chloride
N_2O	Nitrous oxide, laughing gas	Dinitrogen monoxide
$CaCO_3$	Marble, chalk, limestone	Calcium carbonate
$NaHCO_3$	Baking soda	Sodium hydrogen carbonate
$MgSO_4 \cdot 7H_2O$	Epsom salt	Magnesium sulfate heptahydrate
$Mg(OH)_2$	Milk of magnesia	Magnesium hydroxide

How do you write formulas for ***binary ionic compounds*** given the name?

Two simple steps:

1. Write the symbol and charge of each ion
2. Balance the charges by providing subscripts

Magnesium chloride

Mg^{+2} Cl^{-1}

Cl^{-1}

$MgCl_2$

Write the symbol and charge of each ion.

Balance the charges by supplying subscripts. Subscripts tell how many of each atom is present. You need a second Cl^{-1} to balance the charges

More examples: Iron III bromide

Fe^{+3}

Br^{-1}
Br^{-1}
Br^{-1}

Write the symbol and charge of each ion. The charge of the iron is provided by the Roman Numeral.

$FeBr_3$

Balance the charges by supplying subscripts. The subscripts tell how many of each ion is needed to balance the compound.

You'll need three bromine ions to balance the one iron.

Aluminum Sulfide

Al^{+3} S^{-2}

Al^{+3} S^{-2}

S^{-2}

Al_2S_3

Write the symbol and charge of each ion.

Balance the charges by supplying subscripts.

In this case the charges do not evenly divide into each other. You must find the least common multiple. SIX

How many aluminums are needed to arrive at a +6 charge? 2

How many sulfurs are needed to arrive at a -6 charge? 3

Second Category of compounds – Ternary Ionic Compounds. These compounds contain at least one polyatomic ion.

What is a polyatomic ion?

Let's look at the name to try to understand.

It is an **ion** – that means it has a charge.

It is **polyatomic** – that means it is made of more than one atom.

Simple as that!!

Let's look at some examples of polyatomic ions.

CO_3^{-2} carbonate This ion is composed of one carbon and three oxygens and the entire group has a charge of -2.

Polyatomic ion – Group of atoms that act as a unit and carry a charge.

More examples:

SO_4^{-2} Sulfate

SO_3^{-2} Sulfite

ClO_4^{-1} Perchlorate

ClO_3^{-1} Chlorate

ClO_2^{-1} Chlorite

ClO^{-1} Hypochlorite

PO_4^{-3} Phosphate

$C_2H_3O_2^{-1}$ Acetate

OH^{-1} Hydroxide

NO_3^{-1} Nitrate

NO_2^{-1} Nitrite

NH_4^{+1} Ammonium (only positive PI)

You need to learn these!!!

How do you recognize Ternary Ionic Compounds?

Composed of two ions in which at least one is a polyatomic ion.

There is only one positive polyatomic ion (NH_4^{+1})

Three possible types of Ternary Ionic Compounds:

Polyatomic Ions

- Ammonium + negative ion (nonmetal)
- Metal (positive ion) + negative polyatomic ion
- Ammonium + negative polyatomic ion

How do you name Ternary Ionic Compounds?

EASY! PIECE OF CAKE! NO PROBLEM!

Name the first ion.

Name the second ion. Isn't that simple??!!

Examples:

Na_2CO_3

Sodium carbonate

Notice that you do *NOT* change the suffix – just name the polyatomic ion

When you look at this compound you should recognize that this is NOT binary. There are THREE elements present. When you see this, immediately look for a polyatomic ion. ***Carbonate*** is present here.

Name the first ion.

Name the second ion.

A few more examples:

$Fe(OH)_3$

Iron III hydroxide

Name the first ion.

Remember that iron requires a Roman Numeral since it is a transition element. What Roman Numeral should be used?

The Roman Numeral comes from the charge of the ion. How do you find the charge of the iron?

You know two things:

- All compounds are neutral.
- You know the charge of OH (-1)

Since there are 3 OH groups, each with a -1 charge, the charge of the iron must be <u>*+3*</u> for the compound to be neutral

Name the polyatomic ion.

NH_4Cl Name the first ion.

Ammonium chloride Name the second ion.

Notice that since the second ion is a nonmetal that, like binary ionic compounds, the suffix of the nonmetal changes to *–ide*.

$(NH_4)_3PO_4$ Name the first ion.

Ammonium phosphate Name the second ion.

Looks like a monster, but it's really a pussycat.

ONE more example:

Cu_2SO_4

Copper I sulfate

Name the first ion.

You should realize that you need a Roman Numeral since copper is a transition metal.

The Roman Numeral is the same as the charge.

What is the charge?

The charge of sulfate is -2.

Since there are two coppers, the charge of the copper must be +1.

Name the second ion.

Aluminum nitrate

Al^{+3} NO_3^{-1}

First, you can tell from the name that there is a polyatomic ion present (nitrate). All binary ionic compounds have suffixes of *–ide*.

$Al(NO_3)_3$

Write the formula/symbol and charge of each ion.

Balance the charges by supplying subscripts.

Since Al is +3 and NO_3 is -1, you need a total of $3NO_3^{-1}$ to balance one Al^{+3}

Since you will need a subscript of 3 for NO_3^{-1}, you need to put this in parentheses with the 3 outside.

Calcium phosphate

Ca^{+2} PO_4^{-3}

$Ca_3(PO_4)_2$

Write the formula/symbol and charge of each ion.

Balance the charges by supplying subscripts. Since Ca is +2 and PO_4 is -3, you will need 3 Ca+2 to balance 2 PO_4^{-3}

$AlCl_3$

What do you think about this one???

Be careful. This is a metal and nonmetal.

Always keep your Periodic Table in front of you for reference.

You may have been tempted to say "aluminum trichloride". This is INCORRECT!

This is a binary IONIC compound. No prefixes are used. Simply aluminum chloride.

Given the names of binary molecular compounds, how do you write the formulas?

Very easy to do!!! The prefixes tell you how to write the formulas. DO NOT CONSIDER CHARGES. NONMETALS ARE ALL NEGATIVE SO TO USE CHARGES DOES NOT WORK!

Silicon dioxide

SiO_2

Silicon and oxygen are both nonmetals.

The lack of a prefix on silicon means that there is only ONE silicon.

The prefix “di” in front of oxide means that there are TWO oxygens.

Diphosphorous pentachloride

P_2Cl_5

Phosphorous and chloride are both nonmetals.

The prefix “di” means that there are TWO phosphorouses (Is that a word?)

The prefix “penta” before chlorine means that there are five chlorines.

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