POLYATOMIC COMPOUNDS

Text Book Reference: Section 5.9, pages 196 – 198

What's so Radical About Polyatomic Ions?

A "**polyatomic ion**", sometimes also known as a "**radical**" is a group of different atoms of different elements — bonded together to form a single ion, (carrying an overall charge).

In writing formulas, you treat the polyatomic ion as a "**package deal**", as if it were an ion formed from a single atom.

Example: Sulphate ion: SO_4^{-2}
The sulphate polyatomic ion consists of one sulphur atom and four oxygen atoms, and behaves as if it were an element with a valence of 2.

Most common polyatomic ions are negatively charged like the sulphate ion.
The ammonium ion, NH_4^{+1}, is an exception, and is a cation, and behaves like a metal.

Compounds that contain polyatomic ions must contain at least three elements.

Common Polyatomic Ions and Their Ionic Charge

Polyatomic Ion	Ion Formula	Ionic Charge
bicarbonate (hydrogen carbonate)	HCO_3^{-1}	-1
carbonate	CO_3^{-2}	-2
chlorate	ClO_3^{-1}	-1
hydroxide	OH^{-1}	-1
nitrate	NO_3^{-1}	-1
phosphate	PO_4^{-3}	-3
sulphate	SO_4^{-2}	-2

You have already learnt the "**Crossover Rule**" for writing the formula for binary ionic compounds. The same "Crossover Rule" can be used for predicting the formulas of compounds that contain polyatomic ions.

Rules for writing formulas of Compounds that contain Polyatomic Ions

1. Write down the symbols in the order given in the name (metal always first).
2. Record the valence value for each element or polyatomic ion given.
3. Crossover the valence values
4. Find the highest factor common to the two valence values
5. Divide the valence values by this highest factor.
6. Drop any "1" in the formula.

The formula for sodium sulphate is: Na^{+1} $(SO_4)^{-2}$ $\longrightarrow$ Na_2SO_4

The formula for calcium carbonate: Ca^{+2} CO_3^{-2} $\longrightarrow$ $CaCO_3$

Examples

1.Magnesium hydroxide Mg^{+2} $(OH)^{-1}$ $\longrightarrow$ $Mg(OH)_2$

Note: if there is a number after the subscript, then place a bracket around the whole polyatomic ion, (i.e the whole "package deal"). The brackets indicate that the whole polyatomic ion is a single group.

The brackets are kept if, after you have applied the crossover rule, there are two or more polyatomic ions in the formula.

2.Calcium phosphate Ca^{+2} $(PO_4)^{-3}$ $\longrightarrow$ $Ca_3(PO_4)_2$

3.Aluminium sulphate Al^{+3} $(SO_4)^{-2}$ $\longrightarrow$ $Al_2(SO_4)_3$

4.Copper(II) carbonate Cu^{+2} $(CO_3)^{-2}$ $\longrightarrow$ $CuCO_3$

What do the roman numerals after copper indicate?

Why is the formula $CuCO_3$ and not $Cu_2(CO_3)_2$?

How else may we name $CuCO_3$?

5.Plumbic hydroxide Pb^{+4} $(OH)^{-1}$ $\longrightarrow$ $Pb(OH)_4$

What information does the suffix — ic in the name plumbic relate to you?

How else may $Pb(OH)_4$ be named?

6.So what is the formula for Iron (III) nitrate?

To name Polyatomic Compounds

The name is simply a combination of the name of the metal and the name of the polyatomic ion.

Example: Na_2CO_3 (Note: Na^{+1} CO_3^{-2} $\longrightarrow$ Na_2CO_3)
metal + polyatomic ion
So the name is: sodium carbonate

I Using the crossover rule, write the formula for the following:

1. aluminium nitrate _____ 2. potassium hydroxide _____

3. Sodium chlorate _____ 4. zinc carbonate _____

5. sodium bicarbonate _____ 6. copper (II) sulphate _____

7. ferrous sulphate _____ 8. Tin(IV) phosphate _____

9. silver nitrate _____ 10. plumbic sulphate _____

II Write the name for the following, (where there are two names possible, i.e. stock and classical, then write both):

1. $LiNO_3$ _____ 2. $Pb(OH)_2$ _____
2. $Cu_3(PO_4)_2$ _____ 4. K_2SO_4 _____
5. $Mg_3(PO_4)_2$ _____ 6. $Sn(NO_3)_2$ _____
7. $Ba(HCO_3)_2$ _____ 8. $Al(OH)_3$ _____
9. $Sb(ClO_3)_3$ _____ 10. $FeSO_4$