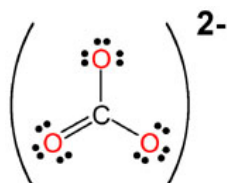
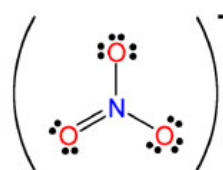


Polyatomic Ions

Certain ions are composed of several atoms that are bonded together through *covalent* bonds. These atoms carry a net charge and can form ionic compounds. For example, the carbonate ion (CO_3^{2-}) is composed of 1 carbon atom and 3 oxygen atoms bonded together. Since there are 2 more electrons than protons, it carries a net charge of -2. However a nitrate ion (NO_3^-) only has a net charge of -1. These can be represented using diagrams called Lewis structures.



carbonate ion



nitrate ion

Table 1: Common Polyatomic Ions

Name of Polyatomic Ion	Formula	Ionic Charge
ammonium	NH_4^+	1+
chlorate	ClO_3^-	1-
hydrogen carbonate (bicarbonate)	HCO_3^{1-}	1-
hydroxide	OH^-	1-
nitrate	NO_3^-	1-
nitrite	NO_2^-	1-
carbonate	CO_3^{2-}	2-
sulfate	SO_4^{2-}	2-
sulfite	SO_3^{2-}	2-
phosphate	PO_4^{3-}	3-

Positively charged metal ions can form stable compounds with these ions:

E.g. calcium carbonate CaCO_3
(1 calcium, 1 carbon and 3 oxygen atoms)

To find the formula for a polyatomic compound, simply consider the polyatomic ion as if it were a single ion:

e.g. 1: What is the chemical formula of calcium carbonate?

2+ 2-

The formula = _____

Ca CO_3

e.g. 2: What is the chemical formula of ammonium sulfate?

NH_4^+ ion
1+

SO_4^{2-} ion
2-

The formula = _____

NH_4 SO_4

THE BINARY ACIDS

Compounds in which hydrogen is the first element are usually called acids when they are dissolved in water or in the aqueous (aq) state. Binary acids are named in the form hydro_____ acid.

hydrogen	+	fluorine	forms	<u>hydrofluoric acid (HF)</u>
hydrogen	+	chlorine	forms	<u>hydrochloric acid (HCl)</u>
hydrogen	+	bromine	forms	<u>hydrobromic acid (HBr)</u>
hydrogen	+	sulfur	forms	<u>hydrosulfuric acid (H₂S)</u>

THE OXYACIDS

Many acids are formed as compounds formed between hydrogen and polyatomic ions. Since the charge on the hydrogen ion is +1, the formula of an oxyacid can contain up to 3 hydrogens (see Table 2).

Table 2: Common Oxyacids

Name of Oxyacid	Formula
chloric acid	HClO_3
nitric acid	HNO_3
nitrous acid	HNO_2
carbonic acid	H_2CO_3
sulfuric acid	H_2SO_4
sulfurous	H_2SO_3
phosphoric acid	H_3PO_4

COUNTING ATOMS

The brackets around a polyatomic ion mean we have two of these groups of atoms. It is important to count the total number of atoms in any compound. Remember that the subscript indicates the number of each atom OR group of atoms. Therefore ammonium sulfate, $(\text{NH}_4)_2\text{SO}_4$, consists of $(2 \times \text{NH}_4^+) + (1 \times \text{SO}_4^{2-})$.

The number of atoms in the compound $(\text{NH}_4)_2\text{SO}_4$ is:

hydrogen (H): _____
nitrogen: _____
sulfur: _____
oxygen: _____

QUESTIONS:

1. Write the name for each compound containing polyatomic ions..

- | | |
|---------------------------------------|---------------------------------------|
| a) CaSO_3 _____ | k) $\text{Al}(\text{OH})_3$ _____ |
| b) NaNO_3 _____ | l) FeCO_3 _____ |
| c) K_3PO_4 _____ | m) $\text{Sn}(\text{NO}_2)_2$ _____ |
| d) NaOH _____ | n) $\text{Be}(\text{NO}_3)_2$ _____ |
| e) NH_4Cl _____ | o) KOH _____ |
| f) Li_2SO_4 _____ | p) $\text{Pb}(\text{CO}_3)_2$ _____ |
| g) $\text{Ca}(\text{ClO}_3)_2$ _____ | q) CuClO_3 _____ |
| h) $\text{Ba}_3(\text{PO}_4)_2$ _____ | r) Cu_2SO_4 _____ |
| i) NaHCO_3 _____ | s) $\text{Mg}(\text{OH})_2$ _____ |
| j) AlPO_4 _____ | t) $(\text{NH}_4)_3\text{PO}_4$ _____ |

2. Write the chemical formula for the following compounds.

- | | |
|--------------------------------|----------------------------|
| a) sodium sulfite _____ | k) tin (II) sulfate _____ |
| b) ammonium hydroxide _____ | l) tin (IV) sulfate _____ |
| c) iron (III) nitrate _____ | m) aluminum nitrate _____ |
| d) copper (I) carbonate _____ | n) silver nitrate _____ |
| e) lead (II) sulfate _____ | o) iron (II) sulfite _____ |
| f) beryllium bicarbonate _____ | p) sodium sulfate _____ |
| g) iron (III) nitrite _____ | q) lead (IV) nitrate _____ |
| h) sodium phosphate _____ | r) cesium nitrate _____ |
| i) calcium hydroxide _____ | s) barium hydroxide _____ |
| j) sodium hydroxide _____ | t) ammonium fluoride _____ |

3. Name the following acidic compounds.

- | | |
|--|--|
| a) $\text{HCl}_{(\text{aq})}$ _____ | k) $\text{H}_3\text{PO}_4_{(\text{aq})}$ _____ |
| b) $\text{HClO}_3_{(\text{aq})}$ _____ | l) $\text{H}_2\text{S}_{(\text{aq})}$ _____ |
| c) $\text{H}_2\text{SO}_3_{(\text{aq})}$ _____ | m) $\text{HNO}_2_{(\text{aq})}$ _____ |

4. Write the formula for the following acids.

a) sulfuric acid _____ k) carbonic acid _____

b) hydrofluoric acid _____ l) nitric acid _____

c) hydrobromic acid _____ m) hydroiodic acid _____

5. For each compound, count the number of each type of atom in the formula.

a) Li_2SO_4

atom	#
Li	
S	
O	

d) $\text{Ca}(\text{ClO}_3)_2$

atom	#

g) $\text{Mg}(\text{OH})_2$

atom	#

b) $\text{Mg}_3(\text{PO}_4)_2$

atom	#
Mg	
P	
S	

e) $\text{Be}(\text{HCO}_3)_2$

atom	#

h) $\text{Al}_2(\text{Cr}_2\text{O}_7)_3$

atom	#

c) $(\text{NH}_4)_3\text{PO}_4$

atom	#
N	
H	
P	
O	

f) $\text{Al}(\text{OH})_3$

atom	#

i) NH_4OH

atom	#

6. Below are some common errors that students make when writing chemical formulas.

For each compound, identify the error and write the correct chemical formula.

a) sodium phosphate, Na_3P _____

b) potassium sulfite, KSO_3 _____

c) calcium sulfite, CaSO_{32} _____

d) sodium nitrite, NaNO _____

7. Below are some common errors students make when naming compounds.

For each compound, identify the error and write the correct name.

a) NaOH , sodium hydrogen oxide _____

b) Al_2S_3 , aluminum sulfite _____

c) Na_2CO_3 , sodium carbide _____

d) FeCO_3 , iron cobalt (III) _____