Colegio de
San Francisco de Paula

How to become a formulation hero

Basics – you will need to know these…and a couple more!

Write the symbols and oxidation numbers for these elements (*hint: these only have one ox. number*)**:**

1. Lithium, sodium and potassium (*Group 1 elements*)
2. Beryllium, magnesium and calcium (*Group 2 elements*)
3. Boron and aluminium (*Group 3 elements*)
4. Oxygen
5. Zinc
6. Silver

For these elements (*hint: these have more than one*)**:**

1. Carbon
2. Nitrogen
3. Sulfur
4. Chlorine, bromine, iodine and astatine
5. Iron, cobalt and nickel
6. Palladium and platinum
7. Copper and mercury
8. Gold

Formulate the ions and include the charges on each:

1. *Example – Ox**ide*** → O^{2-}
   *(Any ion that ends in "**ide**" only contains 1 type of element)*
2. Perox**ide** (*the only time that oxygen does not have a oxidation number of -2)*
3. Hydr**ide**
4. Chlor**ide**, iod**ide** and brom**ide**
   (*Any ion that ends with "ite" or "ate" always contain oxygen)*
5. **Hypo**chlor**ite**, **hypo**iod**ite**, **hypo**brom**ite**
6. Chlor**ite**, iod**ite**, brom**ite**
7. Chlor**ate**, iod**ate**, brom**ate**
8. **Per**chlor**ate**, **per**iod**ate**, **per**brom**ate**
9. Sulfide
10. Sulfite
11. Sulfate
12. Nitride
13. Nitrite
14. Nitrate

15. Carbonate
16. Silicate
17. Borate
18. Phosphate
19. Arsenate
20. Chromate and **di**chromate
21. Manganate and **per**manganate

Hint for formulation

When we are formulating chemical compounds we must follow 1 simple rule. When we add the oxidation numbers (of the element) and the charges on the ions, we must ensure that they equal 0.

Example 1:

Lithium sulfate – Lithium is in group 1 so will have an oxidation state of +1. The sulfate ion has a charge of 2- (SO_4^{2-}). So, to formulate this compound I will need 2 lithium atoms and 1 sulfate ion…

$$+1 \quad +1 \quad -2 \quad = \quad 0$$

$$Li_2SO_4$$

Example 2:

Gold(III) silicate – In this case gold has an oxidation state of +3 (remember it can also have +1). The silicate ion has a charge of 4- (SiO_4^{4-}). So, to formulate this compound I will need 4 gold atoms and 3 silicate ions…

$$+3 \quad +3 \quad +3 \quad +3 \quad -4 \quad -4 \quad -4 \quad = \quad 0$$

$$Au_4(SiO_4)_3$$

Easy formulation

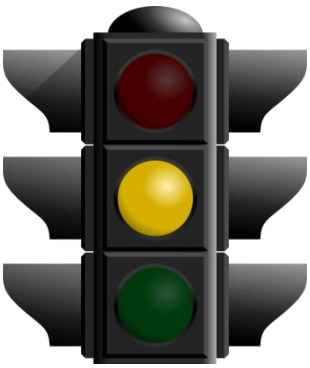
1. Lithium hydride
2. Magnesium hydride
3. Aluminium hydride
4. Calcium oxide
5. Iron(II) sulfide
6. Zinc carbonate
7. Gold(I) bromide
8. Gold(III) fluoride
9. Cobalt(III) hydroxide
10. Cobalt(II) nitride
11. Fe_2O_3
12. $Pt(OH)_2$
13. $Pt(OH)_4$
14. NiO

15. $NiBr_3$
16. CuS
17. Cu_2O
18. CuO_2
19. $HgCl$
20. $HgCl_2$

Some common names that you just have to remember:

- NH_3 ammonia
- CH_4 methane
- BH_3 borane
- B_2H_6 **di**borane (*because it is formed by 2 boranes*)
- H_2O water

Medium difficulty formulation (*combining more complicated metals and ions*)



1. Titanium(II) hypochlorite
2. Titanium(IV) chlorite
3. Zinc bromate
4. Silver perbromate
5. Calcium chromate
6. Calcium dichromate
7. Lithium nitride
8. Potassium nitrite
9. Sodium nitrate
10. Aluminium sulfite
11. Cobalt(II) arsenate
12. Lead(IV) cyanide
13. Lead(II) cyanate
14. Potassium manganate
15. Potassium permanganate
16. $Be(IO_3)_2$
17. Li_2O_2
18. $Ni(NO_3)_3$
19. Rb_2SO_3
20. $Au(ClO)_3$
21. $Pb(IO_4)_4$
22. $CrMnO_4$
23. $Zn_3(PO_4)_2$
24. $HgCN$
25. $Hg(CN)_2$
26. $SnSiO_4$
27. $FeBr_3$
28. $Mn(OH)_2$
29. Ag_2CO_3

30. $Ti(NO_2)_2$

Naming acids

Acids cause the most problems in formulation because they follow a slightly different logic. Any compound whose formula begins with hydrogen is called an acid. Therefore its name must end with "acid".

Example 1 – if we followed the normal rules for naming chemicals then **HCl** would be called **hydrogen chloride**. However, because the formula begins with an **H** we must call it …… acid. In this case, **hydrochloric acid**.

Example 2 - if we followed the normal rules for naming chemicals then **H_2SO_4** would be called **hydrogen sulfate**. However, because the formula begins with an **H** we must call it …… acid. In this case, **sulfuric acid**.

Basic rules for naming acids:

- If a compound contains only hydrogen and 1 other element → **hydro**……**ic acid**
  e.g. HBr → **hydro**brom**ic acid** H_2S → **Hydro**sulfur**ic acid**
- For the group 7 acids that also contain oxygen we must convert their names as shown below:

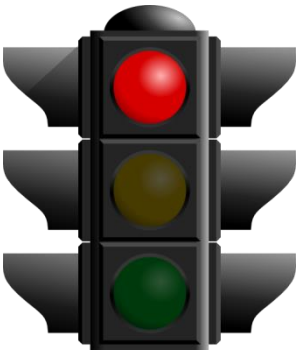
Formula	**Expected name**	**Actual name**
HClO	Hydrogen **hypo**chlor**ite**	**Hypo**brom**ous** acid
$HClO_2$	Hydrogen chlor**ite**	Brom**ous** acid
$HClO_3$	Hydrogen chlor**ate**	Chlor**ic** acid
$HClO_4$	Hydrogen **per**chlor**ate**	**Per**chlor**ic** acid

- For other common acids (with S, N or P) where there are 2 possibilities we use the endings "ous" and "ic" depending on whether the lowest or highest ox. number is being used:

Lowest ox. number			**Highest ox. number**		
Sulfur**ous** acid	H_2SO_3	(S^{+4})	Sulfur**ic** acid	H_2SO_4	(S^{+6})
Nitr**ous** acid	HNO_2	(N^{+3})	Nitr**ic** acid	HNO_3	(N^{+5})
Phosphor**ous** acid	H_3PO_3	(P^{+3})	Phosphor**ic** acid	H_3PO_4	(P^{+5})

Difficult formulation

1. Hypobromous acid
2. Iodic acid
3. Hydroiodic acid
4. Phosphoric acid
5. Phosphorous acid
6. Nitric acid
7. Hydrochloric acid
8. Hydroselenic acid
9. Periodic acid



10. Chlorous acid
11. HNO_3
12. H_2O (trick question)
13. H_2S
14. $HBrO_3$
15. HI
16. $HClO_4$
17. $HClO_3$
18. H_2SO_4
19. HIO_2
20. H_3PO_3

If you can do these then you are a formulation hero.

Congratulations!