Writing Formulas - Naming Compounds

This program demonstrates how to write chemical formulas as well as naming inorganic compounds and acids.

Please read each section carefully. You might wish to take notes.

Note that the oxidation state for atoms has the sign and then number, while the charge on a polyatomic ion has the number and then sign.

Writing Chemical Formulas

1) For 2 elements having different oxidation states:

a) write the symbols, listing the element with a positive oxidation state first (this will be a metal or something acting like a metal)

example: Ca F

b) above each symbol, place the oxidation state of that element

example:
+2 -1
Ca F

c) subscripts must be written below and to the right of the symbols so that the sum of electrons lost will be equal to the number gained. These subscripts must be in the lowest whole number ratio.

In our example the calcium atom will lose 2 outershell (valence) electrons

---> CaF_2

2) For 2 elements having the same oxidation states:

a) subscripts will not be needed for ionically bonded compounds

b) molecular weights are used to determine subscripts for covalently bonded compounds

c) remember never to use `1' as a subscript

example:
+2 -2
Ca O ---> CaO

Here each atom of calcium lost two electrons and each oxygen atom gained two electrons

example: +2 1-
Ca ClO_3 ---> $Ca(ClO_3)_2$

example: +1 1-
K ClO_3 ---> $KClO_3$

Now we need to look at lots of examples.

Problem # 1: potassium + oxygen

+1 -2 ---> K_2O 2 potassium atoms are needed to supply
K O 1 electron each to the oxygen

Problem # 2: beryllium + iodine

+2 -1 ---> BeI_2 the two iodide atoms take one electron
Be I each from the beryllium atom

Problem # 3: calcium + carbon

+2 -4 ----> Ca_2C 2 calcium atoms give up 2 electrons each
Ca C (4 electrons total)

Problem # 4: magnesium + nitrogen

+2 -3 ----> Mg_3N_2 3 magnesium atoms give up 6 electrons,
Mg N 2 nitrogen atoms take in 6 electrons

Problem # 5: calcium + bromate

+2 1- ----> $Ca(BrO_3)_2$ each calcium loses 2 electrons,
Ca BrO_3 each of 2 bromate ions gains 1

Problem # 6: sodium phosphate

+1 3- ----> Na_3PO_4 3 sodium atoms donate an electron
Na PO_4 to the single phosphate ion

Problem # 7: aluminum sulfate

+3 2- ----> $Al_2(SO_4)_3$ magic number = 6 electrons
Al SO_4 transferred from Al to sulfates

Problem # 8: ammonium hydroxide

1+ 1- ----> NH_4OH each ammonium loses 1 electron to
NH_4 OH each hydroxide ion

Problem # 9: lithium oxide

+1 -2 ----> Li_2O 2 lithium atoms are needed to give
Li O up the 2 total electrons needed

Problem # 10: strontium chlorate

-2 1- ----> $Sr(ClO_3)_2$ 2 chlorate ions accept 1 electron
Sr ClO_3 each from the strontium atom

Naming Compounds

1) The nometal name of binary compounds (those consisting of only 2 type elements) must end in 'ide'.

$NaCl$ = sodium chloride CaO = calcium oxide

K_2S = potassium sulfide $AlCl_3$ = aluminum chloride

Mg_3N_2 = magnesium nitride $BaBr_2$ = barium bromide

2) For transition metals, metalloids, or other metals with multiple oxidation states, calculate what that state must be:

$FeCl_2$ = iron (II) chloride $FeCl_3$ = iron (III) chloride

$SnCl_2$ = tin (II) chloride $SnCl_4$ = tin (IV) chloride

$Fe(OH)_3$ = iron (III) hydroxide $Sn(NO_3)_2$ = tin (II) nitrate

Several harder problems show that the oxidation state of the metal must equal that of the nonmetal.

$CuSO_4$ = copper (II) sulfate (since sulfate is 2- the copper must be +2)

$Ni_3(PO_4)_2$ = nickel (II) phosphate (phosphate is 3- but the two of them nickel atoms give up 2 electrons each)

Now we need to look at lots of examples. After you are given the formula figure out on paper what you think the final chemical name would look like.

Problem # 1: $KmnO_4$

potassium permanganate (potassium's only oxidation state is +1 so no Roman numerals needed)

Problem # 2: $MgCO_3$

magnesium carbonate

Problem # 3: Au_3PO_4

gold (I) phosphate (phosphate is 3- so each gold atom must be a +1)

Problem # 4: $HgCO_3$

mercury (II) carbonate (carbonate's charge is 2- so the one mercury must be +2)

Problem # 5: $Cr_3(AsO_4)_2$

chromium (II) arsenate (the two arsenates gain 6 electrons, so each chromium must lose 2 electrons)

Acid Nomenclature

When working with inorganic acids, always start with the `ate' polyatomic ion.

example: CO_3 has a 2- charge so 2 hydrogens will be needed:

+1 2-
H_2CO_3 this would be named: carbonic acid

The six most common acids we use are given next. They all end in `ic'

$HbrO_3$ bromic acid H_3PO_4 phosphoric acid

$HClO_3$ chloric acid H_2SO_4 sulfuric acid

HNO_3 nitric acid H_2CO_3 carbonic acid

Use these as starting points for the alternative acid (and their names)

Rules for Naming Acids/Writing their Formulas

Rule 1: all acids must contain hydrogen

Rule 2: acids with `ic' suffix represent natural `ate' polyatomic ions

$HBrO_3$ bromic acid

Rule 3: when all oxygen atoms are removed, add `hydro' prefix to name

HBr hydrobromic acid HCl hydrochloric acid

Rule 4: when an extra oxygen is added, add a `per' prefix to name

$HBrO_4$ perbromic acid $HClO_4$ perchloric acid

Rule 5: when 1 oxygen is taken away (from `ate' ion number), change the `ic' suffix to `ous'

$HbrO_2$ bromous acid $HClO_2$ chlorous acid

Rule 6: when 2 oxygens are taken away (from `ate' ion number), change the `ic' suffix to `ous' and add a `hypo' prefix

HBrO hypobromous acid HClO hypochlorous acid

Many more examples are available in class. Please see Mr. Jones for these.

Writing Formulas and Naming Compounds. Check your answers in class to each of these

Al_2S_3

copper (I) nitrate

NaCl

Fe_2O_3

calcium bromate

$NaC_2H_3O_2$

copper (II) phosphite

Ca_3P_2

$Mn(BrO_3)_2$

potassium carbonate

sodium hypochlorite

$AlCl_3$

magnesium fluoride

KNO_3

potassium silicate

sodium sulfate

ammonium chloride

$MgCO_3$

Li_2SO_4

$PbSO_4$

lithium carbide

$Ga(ClO_4)_3$

beryllium iodide

carbon (IV) oxide

Na_3P

$Fe(OH)_3$

ammonium nitride

$Ni_3(AsO_4)_2$

CO

CO_2

tin (II) chromate

Rb_3PO_3

$(NH_4)_2SO_3$

silicon (IV) oxide

sodium cyanide

copper (II) acetate

PCl_3

PCl_5

mercury (II) iodide

$Pb(NO_3)_2$

rubidium cyanide

zinc iodide

ACIDS:

bromic acid

$HC1O_4$

H_2CO_3

pernitric acid

phosphoric acid

Side A -- Nomenclature

The names/formulas for these problems are found on webpage: Side B

1) $FeCl_3$

2) $Ba(OH)_2$

3) ammonium phosphate

4) nitric acid

5) hydrogen sulfide

6) phosphoric acid

7) Hg_2SO_4

8) sodium nitrate

9) calcium acetate

10) H_3PO_4

11) AuP

12) K_2O

13) HCI

14) tin (II) permanganate

15) $Pb(C_2H_3O_2)_2$

16) Hg_2P_3

17) lithium hypochlorite

18) lead (II) chromate

19) Zn0

20) hypochlorous acid

21) nickel (II) chlorite

22) lead (II) sulfide

23) $Cu(C1O_3)_2$

31) Ag_3AsO_4

32) aluminum iodide

33) $(NH_4)_2SO_3$

34) Hg0

35) $Be_3(PO_3)_2$

36) potassium chromate

37) $(NH_4)_3AsO_4$

38) calcium silicate

39) $MgCO_3$

40) $Ni(OH)_2$

41) tin (II) perchlorate

42) lead (II) hydroxide

43) sodium sulfate

44) $FrC_2H_3O_2$

45) zinc phosphate

46) tin (II) fluoride

47) $Al(MnO_4)_3$

48) $Mg(C10)_2$

49) strontium silicate

50) K_3AsO_4

51) lithium cyanide

52) $(NH_4)_2SO_4$

53) HC1O

24) RbBr

25) calcium bromate

26) ammonium sulfate

27) $Mg(C10)_2$

28) beryllium cyanide

29) $Cu(OH)_2$

54) Mn_2O_7

55) K_2O

56) lead (II) chromate

57) Hg_3N_2

58) $ZnCrO_4$

59) Au_3P

Side B - Nomenclature

The companions to these nomenclature problems are found on webpage: Side A

1) iron (III) chloride

2) barium hydroxide

3) $(NH_4)_3PO_4$

4) HNO_3

5) H_2S

6) H_3PO_4

7) mercury (I) sulfate

8) $NaNO_3$

9) $Ca(C_2H_3O_2)_2$

10) phosphoric acid

11) gold (III) phosphide

12) potassium oxide

13) hydrochloric acid

14) $Sn(MnO_4)_2$

31) silver arsenate

32) AlI_3

33) ammonium sulfite

34) mercury (II) oxide

35) beryllium phosphite

36) K_2CrO_4

37) ammonium arsenate

38) $CaSiO_3$

39) magnesium carbonate

40) nickel (II) hydroxide

41) $Sn(ClO_4)_2$

42) $Pb(OH)_2$

43) Na_2SO_4

44) francium acetate

15) lead (1I) acetate

16) mercury (II) phosphide

17) LiClO

18) $PbCrO_4$

19) zinc oxide

20) HClO

21) $Ni(ClO_2)_2$

22) PbS

23) copper (II) chlorate

24) rubidium bromide

25) $Ca(BrO_3)_2$

45) $Zn_3(PO_4)_2$

46) SnF

47) aluminum permanganate

48) magnesium hypochlorite

49) $SrSiO_3$

50) potassium arsenate

51) LiCN

52) ammonium sulfate

53) chloric acid

54) manganese (VII) oxide

55) potassium oxide