Chemical Nomenclature: Naming Compounds

New Nomenclature: refers to names for compounds which do not have polyatomic ions.

A) Naming Binary Covalent Compounds (2 nonmetal atoms present)

Rule: Use Greek prefixes to indicate the number of each kind of atom in the compound. Add 'ide' to each ending.

Greek Prefixes

1. mono
2. di
3. tri
4. tetra
5. penta
6. hexa
7. hepta
8. octa
9. nona
10. deca

e.g. N_2O_4 = dinitrogen tetraoxide
NI_3 = mononitrogen triiodide or nitrogen triiodide ('mono' may be dropped)
CO = carbon monoxide (most common) or monocarbon monoxide or monocarbon oxide
P_4O_{10} = tetraphosphorous decaoxide

You name the following:

1. P_2O_5 diphosphorus pentaoxide
2. CCl_4 carbon tetrachloride
3. PBr_5 phosphorus pentabromide
4. N_2O_3 dinitrogen trioxide
5. PO_3 phosphorus trioxide
6. S_2Cl_2 disulfer dichloride
7. Cl_2O_6 dichlorine hexaoxide
8. CO_2 carbon dioxide
9. HI hydrogen monoiodide
10. N_2O dinitrogen monoxide

B) Naming Binary Ionic Compounds (a metal + a nonmetal)

How you will name this type of compound depends on whether the metal always has the same charge or not (if there is only one charge in the bottom of the element's 'box' on the periodic table then this is the only charged ion it can form. If there is more than one charge here, then the element forms each of these charged ions, depending on the circumstances – the charge written first is the more common one).

Naming Ionic Compounds When the Metal has Only One Charge
(Type 1 Ionic compounds)

Rule: Write the name of the metal, then the name of the nonmetal, then add ide.

e.g. Na_2O = sodium oxide
AlN = aluminum nitride
MoO_3 = molybdenum oxide

Now you try:

1. ZnF_2 zinc fluoride
2. Cs_3N cesium nitride
3. AgCl silver chloride
4. Ca_3N_2 calcium nitride
5. Rb_2S rubidium sulfide
6. CdO cadmium oxide
7. BaI_2 barium iodide
8. KBr potassium bromide
9. $BeAt_2$ beryllium astatide
10. Zn_3N_2 zinc nitride

Now try this question. There are binary covalent compounds and binary ionic compounds (Type1) mixed together:

e.g. SO_3 = sulfur trioxide
K_2O = potassium oxide

1. N_2S_4 dinitrogen tetrasulfide
2. SrO Strontium oxide
3. Ba_3N_2 barium nitride
4. PI_5 phosphorus pentaiodide
5. CaS calcium sulfide
6. Br_2S_6 dibromine hexasulfide
7. $ZnCl_2$ zinc chloride
8. P_2S_3 diphosphorus trisulfide
9. Ag_3N silver nitride
10. SBr_6 sulfur hexabromide

Naming Ionic Compounds When the Metal is Capable of Forming Different Ion Charges
(Type 2 Ionic Compounds)

Rule: Since the metal atom can form different charges, you must indicate what charge the metal ion has in this particular compound. A roman numeral is used to indicate the charge of one atom of the metal. Write the name of the metal, then the roman numeral (in brackets), then the name of the nonmetal, and add 'ide'.

e.g. FeO = iron (II) oxide

1= I, 2=II, 3=III, 4=IV, 5=V, 6=VI, 7=VII

$CuBr_2$ = copper (II) bromide

Cu_2O = copper (I) oxide

Cu_3N_2 = copper (II) nitride

Au_3N = gold (I) nitride

AuN = gold (III) nitride

You try these:

1. PbO_2 lead (IV) oxide
2. MnO manganese (II) oxide
3. PbS lead (II) sulfide
4. FeN iron (III) nitride
5. CuO copper (II) oxide
6. PdO_2 palladium (IV) oxide
7. Cr_3N_2 chromium (II) nitride
8. Hg_3N mercury (I) nitride
9. HgS mercury (II) sulfide
10. Fe_2O_3 iron (III) oxide
11. MnS_2 manganese (IV) sulfide
12. CuI copper (I) iodide
13. RuN ruthenium (III) nitride
14. Nb_2O_5 niobium (V) oxide
15. Pt_3N_4 platinum (IV) nitride
16. TiN titanium (III) nitride
17. Cu_2S copper (I) sulfide
18. Hg_3N_2 mercury (II) nitride
19. PtS_2 platinum (IV) sulfide
20. Au_2O gold (I) oxide

Now this next question has binary covalent compounds and binary ionic compounds (both kinds) mixed together. A suggestion... check to see 1.) if there are two nonmetals (then use Greek prefixes). Next, check to see if, in the remaining ionic compounds, 2.) the metal always has the same charge. If so then simply write the metal and nonmetal names and add 'ide'. When you are done these the remaining ionic compounds will need 3.) roman numerals...

1. AuN gold (III) nitride
2. B_2H_4 diboron tetrahydride
3. $CaBr_2$ calcium bromide
4. SF_6 sulfur hexafluoride
5. $PbBr_2$ lead (II) bromide
6. AlN aluminum nitride
7. RbI rubidium iodide
8. N_2O_5 dinitrogen pentaoxide
9. Cu_3N copper (I) nitride
10. HgBr mercury (I) bromide
11. NO nitrogen monoxide
12. Zn_3N_2 zinc nitride
13. Ag_2S silver sulfide
14. Ni_3N_2 nickel (II) nitride
15. OF_2 oxygen difluoride
16. WO_3 tungsten oxide
17. PtO_2 platinum (IV) oxide
18. ClO_2 chlorine dioxide
19. SrS strontium sulfide
20. FeO iron (II) oxide

C) Naming Using Traditional Nomenclature (i.e. polyatomic ions present)

'poly' = many
'ion' = charged particle

polyatomic ion = a **group** of atoms which have an overall charge

Rules: 1) If the cation is NH_4^+, then just write the name of this cation and the name of the anion. (cation = a positively charged ion; anion = a negatively charged ion)

e.g. NH_4Cl = ammonium chloride

$(NH_4)_3N$ = ammonium nitride

NH_4NO_3 = ammonium nitrate

$(NH_4)_3PO_4$ = ammonium phosphate

2) If the cation is not NH_4^+, then it must be a metal. If it is a metal that always has the same charge then name by writing the name of the metal and the name of the polyatomic anion.

e.g. $AlPO_4$ = aluminum phosphate

$Al_2(SO_4)_3$ = aluminum sulphate

You try:

1. $Cs_2C_2O_4$ cesium oxalate
2. $Ca(HCO_3)_2$ calcium bicarbonate
3. Ag_3PO_4 silver phosphate
4. $Cd_3(PO_4)_2$ cadmium phosphate
5. KSCN potassium thiocyanate
6. $(NH_4)_2CO_3$ ammonium carbonate
7. $Ba(CH_3COO)_2$ barium acetate
8. LiOH lithium hydroxide
9. $SrSO_3$ strontium sulfite
10. $Mg_3(BO_3)_2$ magnesium borate
11. ZnS_2O_3 zinc thiosulfite
12. NH_4Br ammonium bromide

Rule 3) If the metal is one whose charge varies, use roman numerals like before:

e.g. $Fe(OH)_2$ = iron (II) hydroxide

Au_2SO_4 = gold (I) sulphate

$Cu_3(PO_4)_2$ = copper (II) phosphate

$NiPO_4$ = nickel (III) phosphate

You try these:

1. $Mn(ClO_3)_2$ manganese (II) chlorate
2. $CuNO_3$ copper (I) nitrate
3. $PbCrO_4$ lead (II) chromate
4. $Pt(C_2O_4)_2$ platinum (IV) oxalate
5. Hg_3BO_3 mercury (I) borate
6. $Bi_2(CO_3)_5$ bismuth (V) carbonate
7. $FePO_4$ iron (III) phosphate
8. $Fe(OH)_3$ iron (III) hydroxide
9. $Ni(C_2H_3O_2)_2$ nickel (II) acetate
10. $NiBO_3$ nickel (III) borate

11. $Ni_3(PO_4)_2$ nickel (II) phosphate
12. $NbPO_4$ niobium (III) phosphate
13. $Pb(ClO)_2$ lead (II) hypochlorite
14. $Pb(S_2O_3)_2$ lead (IV) thiosulfite
15. $Cr_2(Cr_2O_7)_3$ chromium (III) dichromate
16. $Mn(MnO_4)_4$ manganese (IV) permanganate
17. $Hg_2S_2O_3$ mercury (I) thiosulfite
18. $AuClO_2$ gold (I) chlorite
19. Au_3PO_4 gold (I) phosphate
20. $Mn(C_2O_4)_2$ manganese (IV) oxalate

Now try this question. All of the types of compounds that you have learned to name are mixed up here. If you get confused, here is a suggested approach...

1. Look through for all covalent compounds (2 nonmetals) and name these first using Greek prefixes.

2. Next, find all ionic compounds in which the metal only has one charge (regardless of whether there are polyatomic or monatomic anions). Name accordingly by writing the name of the metal, then the name of the nonmetal or polyatomic anion. NH_4^+, ammonium, may be treated the same as a metal with a constant charge.

3. Now, all that remain are ionic compounds in which the metal's charge varies. Use roman numerals to indicate the charge of one atom of the metal.

1. Au_3N gold (I) nitride
2. LiH_2PO_4 lithium dihydrogen phosphate
3. SiF_4 silicon tetrafluoride
4. KCH_3COO potassium acetate
5. NH_4Br ammonium bromide
6. $CuCl_2$ copper (II) chloride
7. B_2Cl_4 diboron tetrachloride
8. $Co_3(BO_3)_2$ cobalt (II) borate
9. SO_3 sulfur trioxide
10. $Al_2(CO_3)_3$ aluminum carbonate
11. $Sc_2(CO_3)_3$ scandium carbonate
12. HCH_3COO hydrogen acetate
13. P_2S diphosphorus monosulfide
14. $Pt(CrO_4)_2$ platinum (IV) chromate
15. $NaOH$ sodium hydroxide
16. MoN_3 molybdenum nitride
17. P_2S_3 diphosphorus trisulfide
18. H_2SO_4 hydrogen sulfate
19. $(NH_4)_2Cr_2O_7$ ammonium dichromate
20. F_2S_6 difluorine hexasulfide

21. NS_3 nitrogen trisulfide
22. Hg_2SO_4 mercury (I) sulfate
23. SiI_4 silicon tetraiodide
24. Cs_2O cesium oxide
25. $Pb(SO_3)_2$ lead (IV) sulfite
26. ZnN zinc nitride
27. $Mn(NO_3)_2$ manganese (II) nitrate
28. NO_2 nitrogen dioxide
29. $Ca(NO_2)_2$ calcium nitrite
30. $Al(OH)_3$ aluminum hydroxide

Writing Formulas for Compounds

A) Writing Formulas for Covalent Compounds (2 nonmetals)

Rule: The Greek prefixes tell you the number of each kind of atom.

e.g. tritellurium hexachloride = Te_3Cl_6
diphosphorus tetrasulphide = P_2S_4

You try:

1. dicarbon tetraoxide C_2O_4
2. carbon tetrachloride CCl_4
3. oxygen hexabromide OBr_6
4. sulphur trioxide SO_3
5. carbon dioxide CO_2
6. diboron tetrahydride B_2H_4
7. sulphur difluoride SF_2
8. diphosphorus pentaoxide P_2O_5
9. carbon monoxide CO
10. nitrogen dioxide NO_2

B) Writing Formulas for Ionic Compounds: Type 1 (metal with constant charge)

Rule: Find the charge of the metal on the periodic table. Write down the ion symbols for the metal and the nonmetal parts. Now put them together to balance the charges.

e.g.

Now try these:

1. sodium chloride $NaCl$
2. sodium oxide Na_2O
3. cesium nitride Cs_3N
4. beryllium sulphide BeS
5. zinc nitride Zn_3N_2
6. calcium fluoride CaF_2
7. silver iodide AgI
8. cadmium oxide CdO
9. lithium nitride Li_3N
10. molybdenum nitride MoN

Now these are still Type 1 Ionic Compounds, but these have polyatomic ions:

e.g.

You try these:

1. silver phosphate Ag_3PO_4
2. calcium chlorite $Ca(ClO_2)_2$
3. ammonium nitrate NH_4NO_3
4. ammonium borate $(NH_4)_3BO_3$
5. cesium oxalate $Cs_2C_2O_4$
6. strontium acetate $Sr(CH_3COO)_2$
7. zinc phosphate $Zn_3(PO_4)_2$
8. aluminum sulphate $Al_2(SO_4)_3$
9. rubidium nitrite $RbNO_2$
10. magnesium thiocyanate $Mg(SCN)_2$

C) <u>Writing Formulas for Type II Ionic Compounds</u> (metal with charge that varies)

Rule: Same idea, except instead of finding the charge of the metal on the periodic table, look at the roman numeral. The roman numeral ***is the charge*** of the metal.

e.g.

Now try:

1. manganese (II) oxide MnO
2. chromium (III) sulfide Cr_2S_3
3. cobalt (II) phosphate $Co_3(PO_4)_2$
4. copper (I) sulphate Cu_2SO_4
5. gold (III) chromate $Au_2(CrO_4)_3$
6. mercury (II) chlorite $Hg(ClO_2)_2$
7. iron (III) oxide Fe_2O_3
8. lead (II) sulphide PbS
9. nickel (III) sulphate $Ni_2(SO_4)_3$
10. titanium (IV) sulfite $Ti(SO_3)_2$
11. chromium (II) nitride Cr_3N_2
12. gold (I) nitrate $AuNO_3$
13. mercury (I) nitrite $HgNO_2$
14. platinum (IV) dihydrogen phosphate $Pt(H_2PO_4)_4$
15. nickel (II) bicarbonate $Ni(HCO_3)_2$
16. lead (IV) carbonate $Pb(CO_3)_2$
17. copper (II) acetate $Cu(CH_3COO)_2$
18. ruthenium (IV) borate $Ru_3(BO_3)_4$
19. vanadium (V) chlorite $V(ClO_2)_5$
20. titanium (III) chlorate $Ti(ClO_3)_3$

Now these are all mixed together:

1. cobalt (II) carbonate $CoCO_3$
2. silver permanganate $AgMnO_4$
3. ammonium chloride NH_4Cl
4. nitrogen trioxide NO_3
5. lead (IV) oxide PbO_2
6. barium borate $Ba_3(BO_3)_2$
7. cobalt (III) bromide $CoBr_3$
8. phosphorus pentabromide PBr_5
9. platinum (IV) oxalate $Pt(C_2O_4)_2$
10. calcium hydroxide $Ca(OH)_2$
11. strontium chromate $SrCrO_4$
12. chromium (II) dichromate $CrCr_2O_7$
13. nitrogen monoxide NO
14. gold (III) sulfide Au_2S_3
15. lithium oxide Li_2O
16. diarsenic pentasulphide As_2S_5
17. molybdenum oxide MoO_3
18. lead (II) nitride Pb_3N_2
19. cadmium acetate $Cd(C_2H_3O_2)_2$
20. dicarbon dichloride C_2Cl_2

21. silicon disulphide SiS_2
22. aluminum thiocyanate $Al(SCN)_3$
23. vanadium (V) nitride V_3N_5
24. diphosphorus tetraoxide P_2O_4
25. gold (I) phosphate Au_3PO_4
26. ammonium hydroxide NH_4OH
27. zinc dihydrogen phosphate $Zn(H_2PO_4)_2$
28. selenium hexaiodide SeI_6
29. potassium chlorate $KClO_3$
30. chromium (III) bicarbonate $Cr(HCO_3)_3$

The Grand Finale!

Directions: If the name is given, then write the formula. If the formula is given, then write the name.

1. P_2S_5 diphosphorus pentasulfide
2. strontium chloride $SrCl_2$
3. oxygen hexachloride OCl_6
4. cesium dichromate $Cs_2Cr_2O_7$
5. SiF_4
6. iron (III) oxide Fe_2O_3
7. manganese (IV) iodide MnI_4
8. AgI Silver iodide
9. NiN nickel (III) nitride
10. radium phosphate $Ra_3(PO_4)_2$
11. dicarbon tetrachloride C_2Cl_4
12. $Pd(S_2O_3)_2$ Palladium (IV) thiosulfite
13. CdF_2 cadmium fluoride
14. $Pd(CrO_4)_2$ palladium (IV) chromate
15. copper (I) nitrate $CuNO_3$
16. $Mn(H_2PO_4)_2$ manganese (II) dihydrogen phosphate
17. calcium hydroxide $Ca(OH)_2$
18. ammonium phosphate $(NH_4)_3PO_4$
19. NO_2 nitrogen dioxide
20. Cu_2O copper (I) oxide
21. tin (IV) carbonate $Sn(CO_3)_2$
22. aluminum oxide Al_2O_3
23. Mg_3N_2 magnesium nitride
24. gold (III) nitride AuN Au_2N_3
25. sodium nitride Na_3N
26. mercury (II) borate $Hg_3(BO_3)_2$
27. Fe_2O_3 iron (III) oxide
28. $Zn(NO_3)_2$ zinc nitrate
29. sulphur dioxide SO_2
30. $Os(HCO_3)_4$ Osmium bicarbonate