

## Chapter 9

### Naming Compounds Writing Formulas

### Systematic Naming

- There are too many compounds to remember the names of them all.
- Compound is made of two or more elements.
- Put together atoms.
- Name should tell us how many and what type of atoms.

### Two Types of Compounds

#### 1 Molecular compounds

- Made of molecules.
- Made by joining nonmetal atoms together into molecules.
- Sometimes hydrogen

### Two Types of Compounds

#### 2 Ionic Compounds

- Made of cations and anions.
- Metals and nonmetals.
- The electrons lost by the cation are gained by the anion.
- The cation and anions surround each other.
- Smallest piece is a FORMULA UNIT.

### Two Types of Compounds

	Ionic	Molecular
Smallest piece	Formula Unit	Molecule
Types of elements	Metal and Nonmetal	Nonmetals
State	solid	Solid, liquid or gas
Melting Point	High >300°C	Low <300°C

### Charges on ions

- For most of Group A elements, location on the Periodic Table can tell what kind of ion they form
- Elements in the same group have similar properties.
- Including the charge when they are ions.

Charge in groups 1A, 2A and 3A is the group number

1+ 2+ in 5A, 6A and 7A 3+ 3- 2- 1-

is the group number - 8

Can also use electron dots

- If it has a few it loses them

$K^+ 3+$

- If it has many, it gains enough for octet

$N^{3-}$

What about the others?

- We have to figure those out some other way.
- More on this later.

Naming ions

- Cation- if the charge is always the same (Group A) just write the name of the metal.
- Most transition metals can have more than one type of charge.
- Indicate the charge with Roman numerals in parenthesis.
- $Co^{2+}$  Cobalt(II) ion

Naming ions

- A few, like silver, zinc and cadmium only form one kind of ion
- Don't get roman numerals
- $Ag^+$  silver ion
- $Zn^{2+}$  zinc ion
- $Cd^{2+}$  cadmium ion

Name these

- $Na^{1+}$  Sodium ion
- $Ca^{2+}$  Calcium ion
- $Al^{3+}$  Aluminum ion
- $Fe^{3+}$  Iron(III) ion
- $Fe^{2+}$  Iron(II) ion
- $Pb^{2+}$  Lead(II) ion
- $Li^{1+}$  Lithium ion

### Write Formulas for these

- Potassium ion  $K^{1+}$
- Magnesium ion  $Mg^{2+}$
- Copper(II) ion  $Cu^{2+}$
- Chromium(VI) ion  $Cr^{6+}$
- Barium ion  $Ba^{2+}$
- Mercury(II) ion  $Hg^{2+}$

### Naming Anions

- Anions are always the same.
- Change the element ending to – ide
- $F^{1-}$  Fluorine

### Naming Anions

- Anions are always the same.
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### Naming Anions

- Anions are always the same
- Change the element ending to – ide
- $F^{1-}$  Fluori

### Naming Anions

- Anions are always the same
- Change the element ending to – ide
- $F^{1-}$  Fluor

### Naming Anions

- Anions are always the same
- Change the element ending to – ide
- $F^{1-}$  Fluori

### Naming Anions

- Anions are always the same
- Change the element ending to – ide
- F<sup>1-</sup> Fluorid

### Naming Anions

- Anions are always the same
- Change the element ending to – ide
- F<sup>1-</sup> Fluoride

### Naming Anions

- Anions are always the same
- Change the element ending to – ide
- F<sup>1-</sup> Fluoride ion

### Name these

- Cl<sup>1-</sup> Chloride ion
- N<sup>3-</sup> Nitride ion
- Br<sup>1-</sup> Bromide ion
- O<sup>2-</sup> Oxide ion
- Ga<sup>3+</sup> Gallium ion

### Write these

- Sulfide ion S<sup>2-</sup>
- Iodide ion I<sup>1-</sup>
- Phosphide ion P<sup>3-</sup>
- Strontium ion Sr<sup>2+</sup>

### Polyatomic ions

- Groups of atoms that stay together and have a charge.
- Covalently bonded
- You must memorize these. (pg 257)

### 1- ions

- Acetate  $\text{C}_2\text{H}_3\text{O}_2^{1-}$
- Nitrate  $\text{NO}_3^{1-}$
- Nitrite  $\text{NO}_2^{1-}$
- Hydroxide  $\text{OH}^{1-}$
- Permanganate  $\text{MnO}_4^{1-}$
- Cyanide  $\text{CN}^{1-}$

### 1- ions

- Perchlorate  $\text{ClO}_4^{1-}$
- Chlorate  $\text{ClO}_3^{1-}$
- Chlorite  $\text{ClO}_2^{1-}$
- Hypochlorite  $^{1-}$

### 2- ions

- Sulfate  $\text{SO}_4^{2-}$
- Sulfite  $\text{SO}_3^{2-}$
- Carbonate  $\text{CO}_3^{2-}$
- Chromate  $\text{CrO}_4^{2-}$
- Dichromate  $\text{Cr}_2\text{O}_7^{2-}$
- Silicate  $\text{SiO}_3^{2-}$

### 3- ions

- Phosphate  $\text{PO}_4^{3-}$
- Phosphite  $\text{PO}_3^{3-}$

### 1+ ion

- Ammonium  $\text{NH}_4^{1+}$

### Adding Hydrogen to Polyatomics

- Hydrogen ions are 1+
- Attach to other polyatomic ions-  
changes charge by one
- Sulfate  $\text{SO}_4^{2-}$
- Hydrogen sulfate  $\text{HSO}_4^{1-}$
- Phosphate  $\text{PO}_4^{3-}$
- Hydrogen phosphate  $\text{HPO}_4^{2-}$
- Dihydrogen phosphate  $\text{H}_2\text{PO}_4^{1-}$

### Ions in Ionic Compounds

### Naming Binary Ionic Compounds

- Binary Compounds - 2 elements.
- Ionic - a cation and an anion.
- The name is just the names of the ions.
- Cation first anion second
- Easy with Group A elements.
- $\text{NaCl} = \text{Na}^+ \text{Cl}^-$  = sodium chloride
- $\text{MgBr}_2 = \text{Mg}^{2+} \text{Br}^-$  = magnesium bromide
- $\text{Na}_2\text{S}$

### Naming Binary Ionic Compounds

- The problem comes with the transition metals.
- Cation name includes the charge.
- The compound must be neutral.
- same number of + and - charges.
- Use the negative charge to find the charge on the positive ion.

### Naming Binary Ionic Compounds

- Write the name of  $\text{CuO}$
- Need the charge of Cu
- O is 2-
- copper must be 2+
- Copper(II) oxide
- Name  $\text{CoCl}_3$
- Cl is 1- and there are three of them = 3-
- Co must be 3+
- Cobalt(III) chloride

### Naming Binary Ionic Compounds

- Write the name of  $\text{Cu}_2\text{S}$ .
- Since S is 2-, the  $\text{Cu}_2$  must be 2+, so each one is 1+.
- copper(I) sulfide
- $\text{Fe}_2\text{O}_3$
- Each O is 2-  $3 \times 2 = 6-$
- 2 Fe must = 6+, so each is 3+.
- iron(III) oxide

### Naming Binary Ionic Compounds

- Write the names of the following
- KCl
- $\text{Na}_3\text{N}$
- CrN
- $\text{Sc}_3\text{P}_2$
- PbO
- $\text{PbO}_2$
- $\text{Na}_2\text{Se}$

### Ternary Ionic Compounds

- Will have polyatomic ions
- At least three elements (3 capital letters)
- Still just name the ions
- $\text{NaNO}_3$
- $\text{CaSO}_4$
- $\text{CuSO}_3$

### Ternary Ionic Compounds

- $(\text{NH}_4)_2\text{O}$
- $\text{Fe}(\text{OH})_3$
- $\text{LiCN}$
- $(\text{NH}_4)_2\text{CO}_3$
- $\text{NiPO}_4$

### Writing Formulas

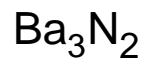
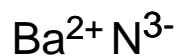
- The charges have to add up to zero.
- Get charges on pieces.
- Cations from name or periodic table.
- Anions from periodic table or polyatomic.
- Balance the charges by adding subscripts.
- Put polyatomics in parenthesis if there is more than one of them

### Writing Formulas

- Write the formula for calcium chloride.
- Calcium is  $\text{Ca}^{2+}$
- Chloride is  $\text{Cl}^{1-}$
- $\text{Ca}^{2+} \text{Cl}^{1-}$  would have a 1+ charge.
- Need another  $\text{Cl}^{1-}$
- $\text{Ca}^{2+} \text{Cl}_2^{1-}$

### Crisscross

- Switch the numerical value of the charges



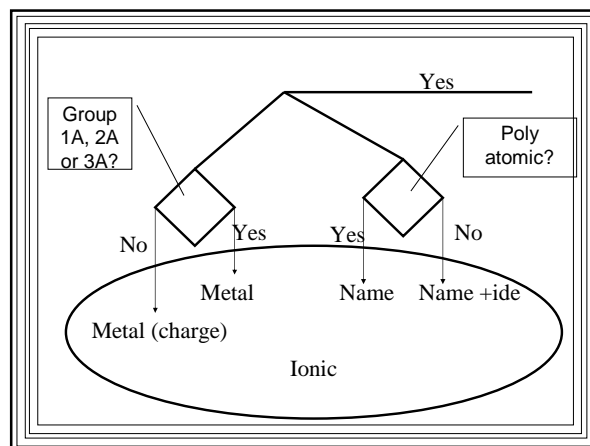
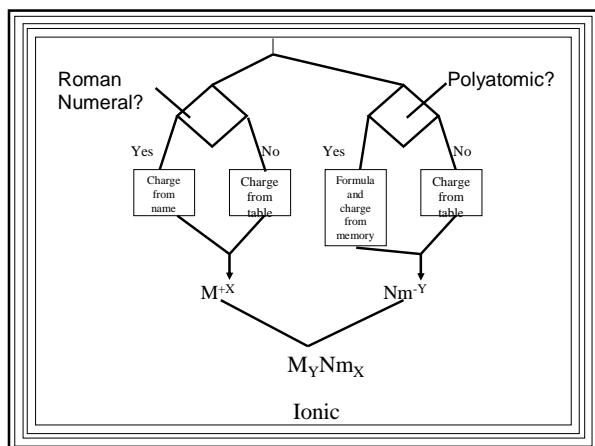
- Reduce ratio if possible

### Write the formulas for these

- Lithium sulfide
- tin (II) oxide
- tin (IV) oxide
- Copper (II) sulfate
- Iron (III) phosphide
- gallium nitrate
- Iron (III) sulfide
- ammonium sulfide

### Write the formulas for these

- Ammonium chloride
- barium nitrate



- ### Things to look for
- If cations have (), the number is their charge. Not how many.
  - If anions end in -ide they are probably off the periodic table (Monoatomic)
  - If anion ends in -ate or -ite it is polyatomic
  - The positive piece always gets written first
  - Hydrogen- it depends on where it's at
    - If it is second, it's a nonmetal -hydride

## Molecular Compounds

Writing names and Formulas

- ### Molecular compounds
- made of just nonmetals
  - smallest piece is a molecule
  - can't be held together because of opposite charges.
  - can't use charges to figure out how many of each atom

- ### Easier
- Ionic compounds use charges to determine how many of each.
  - Molecular compounds name tells you the number of atoms.
  - Uses prefixes to tell you the number



## Prefixes

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

## Naming

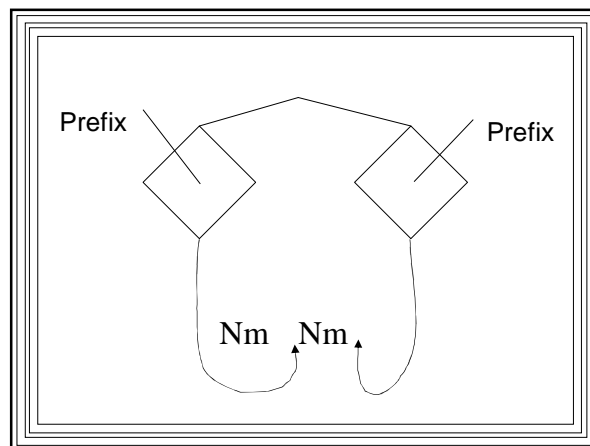
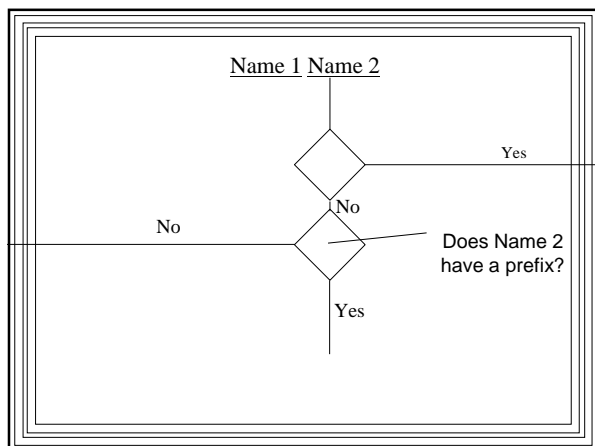
- To write the name write two words  
Prefix name Prefix name -ide
- Exception - we don't write mono- if there is only one of the first element.
- No ao oo double vowels when writing name, io, oi, and ai are okay.

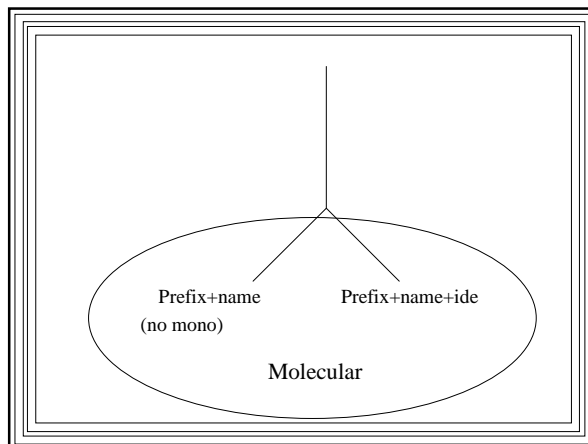
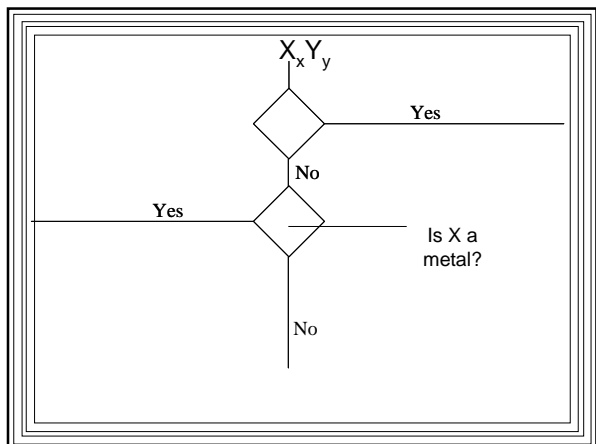
## Name These

- $N_2O$
- $NO_2$
- $Cl_2O_7$
- $CBr_4$
- $CO_2$
- $BaCl_2$

## Write formulas for these

- diphosphorus pentoxide
- tetraiodine nonoxide
- sulfur hexafluoride
- nitrogen trioxide
- Carbon tetrahydride
- phosphorus trifluoride
- aluminum chloride





## Acids and Bases

Writing names and Formulas

- ### Bases
- Produce hydroxide ions when dissolved in water.
  - $\text{OH}^-$
  - Must have hydroxide in them, connected to a metal
  - Same name and formula rules as other ionic compounds
  - $\text{Ca}(\text{OH})_2$  Calcium hydroxide

- ### What is the name of KOH
- A) Potassium hydroxide
  - B) Potassium(I) hydroxide
  - C) Potassium monohydroxide
  - D) Potassium hydroxide
  - E) Potassium oxygen hydride

- ### What is the name of $\text{Pd}(\text{OH})_2$ ?
- A) Palladium hydroxide
  - B) Palladium(I) hydroxide
  - C) Palladium(II) hydroxide
  - D) Palladium dihydroxide

What is the formula for barium hydroxide?

- A) BaOH
- B) BaOH<sub>2</sub>
- C) Ba(OH)<sub>2</sub>
- D) BaHO

What is the formula for iron(III) hydroxide

- A) Fe<sub>3</sub>OH
- B) FeOH<sub>3</sub>
- C) Fe(III)OH
- D) Fe(OH)<sub>3</sub>

### Acids

- Compounds that give off hydrogen ions when dissolved in water.
- Must have H in them.
- will always be some H next to an anion.
- The anion determines the name.

### Naming acids

- If the anion attached to hydrogen is ends in -ide, put the prefix hydro- and change -ide to -ic acid
- HCl - hydrogen ion and chloride ion
- hydrochloric acid
- H<sub>2</sub>S hydrogen ion and sulfide ion
- hydrosulfuric acid

### Naming Acids

- If the anion has oxygen in it
- it ends in -ate or -ite
- change the suffix -ate to -ic acid
- HNO<sub>3</sub> Hydrogen and nitrate ions
- Nitric acid
- change the suffix -ite to -ous acid
- HNO<sub>2</sub> Hydrogen and nitrite ions
- Nitrous acid

### Name these

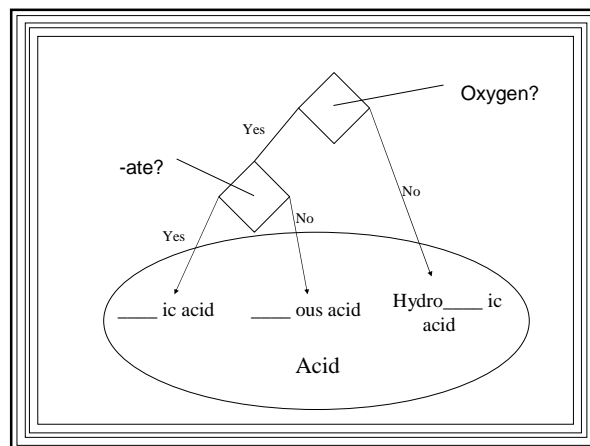
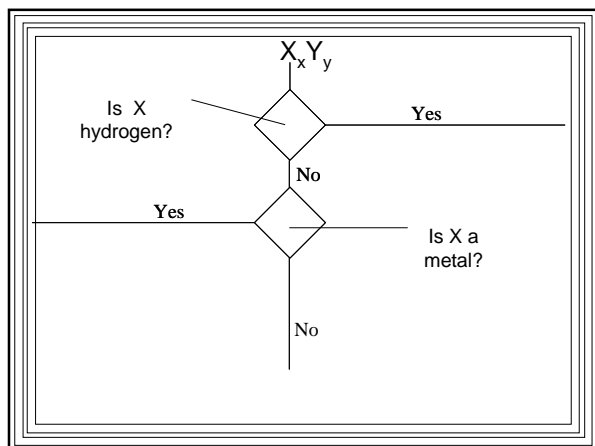
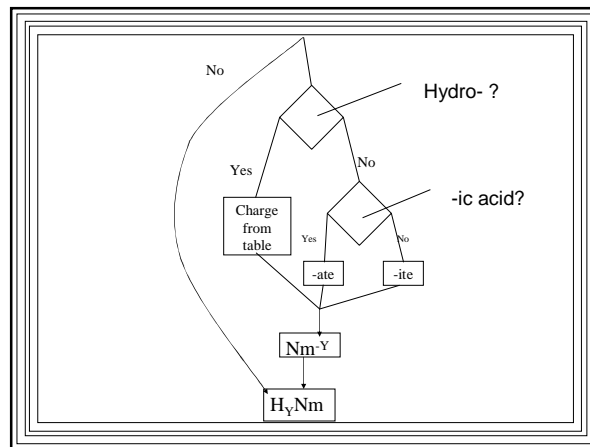
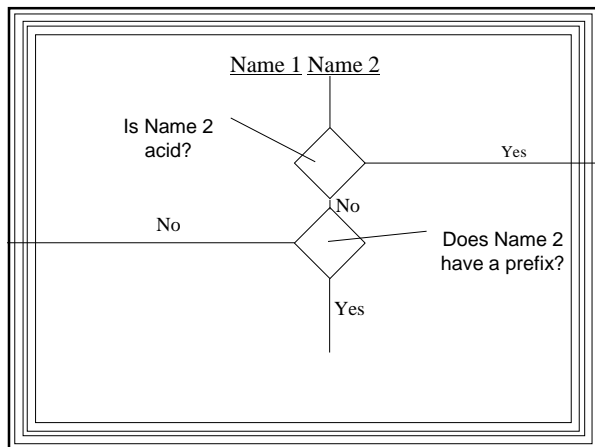
- HF
- H<sub>3</sub>P
- H<sub>2</sub>SO<sub>4</sub>
- H<sub>2</sub>SO<sub>3</sub>
- HCN
- H<sub>2</sub>CrO<sub>4</sub>

## Writing Formulas

- Hydrogen will always be first
- name will tell you the anion
- make the charges cancel out.
- Starts with hydro- no oxygen, -ide
- no hydro, -ate comes from -ic, -ite comes from -ous

## Write formulas for these

- hydroiodic acid
- acetic acid
- carbonic acid
- phosphorous acid
- hydrobromic acid
- diagram



### Name $\text{H}_2\text{C}_2\text{O}_4$

- A) Hydrogen carbon oxide
- B) Hydrogen carbonate
- C) Hydrogen Oxalate
- D) Carbonic acid
- E) Oxalic acid

### Name $\text{HClO}_2$

- A) Hydrochloric acid
- B) Hydrochlorous acid
- C) Chlorous acid
- D) Chloric acid
- E) Hydrogen chlorine dioxide

### Write the formula for nitrous acid

- A)  $\text{H}_3\text{N}$
- B)  $\text{HNO}$
- C)  $\text{HNO}_2$
- D)  $\text{HNO}_3$
- E)  $\text{HNO}_4$

### Write the formula for hydrochloric acid

- A)  $\text{HCl}$
- B)  $\text{HClO}$
- C)  $\text{HClO}_2$
- D)  $\text{HClO}_3$
- E)  $\text{HClO}_4$

### Law of Definite Proportions

- Each compound has a specific ratio of elements.
- It is a ratio by mass.
- Water is always 8 grams of oxygen for each gram of hydrogen.
- Because it has a definite ratio of atoms

- Three samples of a substance containing sodium (Na) and Oxygen (O), were prepared in different ways. Show they follow the law of definite proportion

Sample	Mass of Na in sample	Mass of O in sample	Total mass
A	0.757 g	0.263 g	1.020 g
B	1.149 g	0.399 g	1.548 g
C	1.025 g	0.357 g	1.382 g

## Law of Multiple Proportions

- If two elements form more than one compound, the ratio of the second element that combines with 1 gram of the first element in each, is a simple whole number.
- The ratio of the ratios is a whole number.

## What?

- Water is 8 grams of oxygen per gram of hydrogen.
- Hydrogen peroxide is 16 grams of oxygen per gram of hydrogen.
- 16 to 8 is a 2 to 1 ratio.
- True because you have to add a whole atoms, you can't add a piece of an atom.
- Water is  $H_2O$
- Hydrogen peroxide is  $H_2O_2$

- Two different compounds are formed by the elements carbon and oxygen. The first compound contains 42.9% by mass carbon and 57.1% by mass oxygen. The second compound contains 27.3% by mass carbon and 72.7% by mass oxygen. Show that the data are consistent with the Law of Multiple Proportions.

## Summary

- Make all the decisions.
- First determine type of compound
- Then figure out name or formula
- Acid = H to start
- Metal = Ionic
- No H, No metal = molecular
- Only molecular get prefixes
- Roman numeral is NOT how many
- Hydro means no O

## Summary

- Periodic table
  - Grouped by properties
- Metals- make cations
  - 2 types those with () and those without
- Nonmetals make anions
  - Three types
    - Without O -ide
    - With O -ite and -ate
- Only electrons can move to make ions

38. Name these acids

a)  $H_2C_2O_4$     b) HF    c)  $HClO_2$     d)  $H_2CO_3$

39. Write formulas for these compounds

a) nitrous acid    b) hydroselenic acid  
c) phosphoric acid    d) acetic acid

43. Name these compounds

a)  $AlF_3$     b)  $SnO_2$     c)  $Fe(C_2H_3O_2)_3$   
d)  $KHSO_4$     e)  $CaH_2$     f)  $HClO_3$   
g)  $Hg_2Br_2$     h)  $H_2CrO_4$

44. Write formulas for these

a) Phosphorus pentabromide  
b) Carbon chloride  
c) potassium permanganate

43. Name these compounds

- a)  $\text{AlF}_3$     b)  $\text{SnO}_2$     c)  $\text{Fe}(\text{C}_2\text{H}_3\text{O}_2)_3$   
d)  $\text{KHSO}_4$     e)  $\text{CaH}_2$     f)  $\text{HClO}_3$   
g)  $\text{Hg}_2\text{Br}_2$     h)  $\text{H}_2\text{CrO}_4$

44. Write formulas for these

- a) Phosphorus pentabromide  
b) Carbon chloride  
c) potassium permanganate  
d) Calcium hydrogen carbonate  
e) dichlorine heptoxide  
f) trisilicon tetrahydride  
g) sodium dihydrogen phosphate