

## Ionic Compounds

### Situation #1 – Metal (only 1 ion charge) + Non-metal

- Name the metal off the periodic table                      Name the non-metal changing the ending to "ide"                      *Example – MgCl<sub>2</sub> magnesium chloride*
- To write the formula, balance the ion charges and write the simplest ratio of + to – ions as subscripts. (do not include charges in formulas!)

#### Example – aluminum sulfide

Ions: Al<sup>3+</sup> and S<sup>2-</sup> so... we need 2 Al<sup>3+</sup> and 3 S<sup>2-</sup>                      (+6 balances -6)  
Formula = Al<sub>2</sub>S<sub>3</sub>

### Situation #2 – Multivalent Metal + non-metal

- Most transition metals are multivalent (more than one possible ion charge). Zn<sup>2+</sup> and Ag<sup>+</sup> are exceptions having one possible charge.
- Name the metal off the periodic table including a roman numeral to show which ion charge is used.
- Name the non-metal, changing the ending to "ide"

#### Example: FeCl<sub>2</sub> – iron (II) chloride

(We have two Cl<sup>-</sup> ions (total charge -2) and only 1 Fe ion, so charge must be +2 to balance -2)

#### Example: Copper (I) Oxide

Ions: Cu<sup>+1</sup> and O<sup>2-</sup> ... so we need 2 Cu<sup>+1</sup> ions to balance 1 O<sup>2-</sup> ion  
Formula: Cu<sub>2</sub>O

### Situation #3 – Polyatomic ions (one or both ions in an ionic compound are polyatomic )

- Ammonium (NH<sub>4</sub><sup>+</sup>) can replace a metal and there are many negative polyatomic ions (ex. SO<sub>4</sub><sup>2-</sup>) can replace a non-metal ion in an ionic compound.
- Name them exactly as written on the chart. Do not change ending to "ide"
- If there is more than 1 of a polyatomic ion needed to balance charges, put it in **brackets!**

Example: Calcium Nitrate → Ca(NO<sub>3</sub>)<sub>2</sub>  
Ca<sup>2+</sup> NO<sub>3</sub><sup>-</sup>

### Situation #4 – Ionic Hydrates

- Ionic compounds can form weak bonds with water molecules to form crystals
- The number of water molecules bonded is indicated with a prefix followed by "hydrate"
- The weak bond is indicated with a dot

Example:                      Copper (II) sulphate pentahydrate  
CuSO<sub>4</sub> • 5H<sub>2</sub>O

1. Determine the correct formula for each of the following **ionic compounds**. *Some are hydrates!*

- a. rubidium sulphide .....  $Rb_2S$
- b. manganese (II) chloride .....  $MnCl_2$
- c. sodium oxalate .....  $Na_2C_2O_4$
- d. ammonium dichromate .....  $(NH_4)_2Cr_2O_7$
- e. zinc nitrate tetrahydrate .....  $Zn(NO_3)_2 \cdot 4H_2O$
- f. tungsten (VI) sulphate .....  $W(SO_4)_3$
- g. copper (I) monohydrogen phosphate .....  $Cu_2HPO_4$
- h. manganese (IV) bisulphate .....  $Mn(HSO_4)_4$
- i. calcium acetate .....  $Ca(CH_3COO)_2$
- j. iron (III) carbonate hexahydrate .....  $Fe_2(CO_3)_3 \cdot 6H_2O$
- k. tin (IV) oxide .....  $SnO_2$
- l. ammonium dihydrogen phosphate .....  $NH_4H_2PO_4$
- m. calcium sulphite octahydrate .....  $CaSO_3 \cdot 8H_2O$
- n. nickel (III) chlorate trihydrate .....  $Ni(ClO_3)_3 \cdot 3H_2O$

2. Determine the correct name for each of the following ionic compounds. Some are hydrates!

a.  $\text{Rb}_3\text{PO}_4$  ..... rubidium phosphate

b.  $\text{Fe}(\text{OH})_3$  ..... iron (III) hydroxide

c.  $\text{Cr}_2(\text{SO}_4)_3 \cdot 5\text{H}_2\text{O}$  ..... chromium (III) sulfate pentahydrate

d.  $\text{NH}_4\text{HC}_2\text{O}_4$  ..... Ammonium binoxalate

e.  $\text{Pb}(\text{ClO})_4$  ..... Lead (IV) hypochlorite

f.  $\text{Ba}(\text{OH})_2 \cdot 10\text{H}_2\text{O}$  ..... Barium hydroxide decahydrate

g.  $\text{Hg}_2(\text{NO}_3)_2$  ..... Mercury (I) nitrate

h.  $\text{Cu}_2\text{SO}_3$  ..... Copper (I) sulphite

i.  $\text{Ni}_2(\text{Cr}_2\text{O}_7)_3$  ..... Nickel (III) dichromate

j.  $\text{Ta}(\text{ClO}_4)_2$  ..... Tantalum (II) perchlorate

## Acids vs. Bases

Acids	Bases
Aqueous $H^+$ compounds	Aqueous $OH^-$ compounds
Turn blue litmus red	Turn red litmus blue
$H^+$ appears first in the formula (expect acetic acid $CH_3COOH$ )	$OH^-$ appears last in the formula

### Naming Acids

- **If the negative ion (anion) ends in "ide"** → hydro\_\_\_\_\_ ic acid.
  - Example:  $HCl$   
IUPAC name = Hydrogen Chloride  
Classic name = Hydrochloric Acid
- **If the negative ion (anion) ends in "ate"** → \_\_\_\_\_ ic acid
  - Example:  $H_2SO_4$   
IUPAC name = Hydrogen Sulphate  
Classic name = Sulphuric acid
- **If the negative ion (anion) ends in "ite"** → \_\_\_\_\_ ous acid
  - Example:  $HClO_2$   
IUPAC name = Hydrogen Chlorite  
Classic acid name = Chlorous Acid

### Name the following:

- a.  $H_2SO_3$  sulphurous acid  
*sulphite*
- b.  $HCN$  hydrocyanic acid  
*cyanide*
- c.  $HF$  hydrofluoric acid  
*fluoride*
- d.  $HNO_3$  nitric acid  
*nitrate*

### Naming Bases

- Named as normal ionic compound
- Will always end in hydroxide (unless they are organic bases which we will worry about in our organics unit!)
- Example:  $NaOH$  → Sodium Hydroxide

## Covalent Compounds

- Non-metal atoms share electrons forming a covalent bond which holds them together in a group called a molecule
- Molecular formulas show the # of each type of atom in a molecule

### Molecular Elements

- Some elements always form molecules

H<sub>2</sub>   N<sub>2</sub>   O<sub>2</sub>   F<sub>2</sub>   Cl<sub>2</sub>   Br<sub>2</sub>   I<sub>2</sub>   P<sub>4</sub>   S<sub>8</sub>

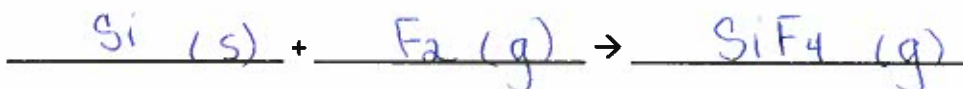
### Molecular Compounds

- You are ALWAYS told how many of each atom through the prefix naming system. (mono, di, tri, tetra, penta, hexa, hepta, octa, nona, deca)
- Covalent compounds DO NOT form ions so you do not need to worry about balancing ion charges!!
- Please note: mono is not used on the first element, only the second. (example: Carbon monoxide)

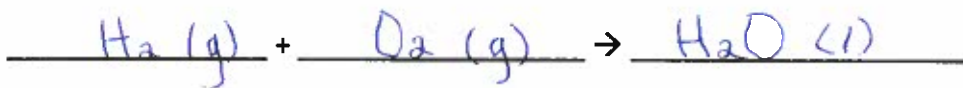
Examples:    dinitrogen oxide = N<sub>2</sub>O  
                  sulfur dioxide = SO<sub>2</sub>  
                  Nitrogen = N<sub>2</sub>  
                  Sucrose = C<sub>12</sub>H<sub>22</sub>O<sub>11</sub>

Write the formulas for each covalent molecule in the reactions below. Include phase subscripts:  
solid = (s)    liquid = (l)    gas = (g)    aqueous (dissolved in water) = (aq)

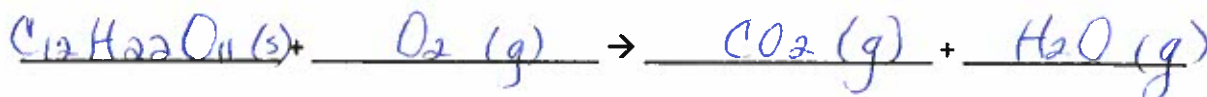
1. Solid silicon reacts with gaseous fluorine to produce gaseous silicon tetrafluoride.



2. Hydrogen and oxygen gases react to produce dihydrogen monoxide.



3. Solid sucrose combusts in the presence of oxygen gas to produce carbon dioxide gas and water vapour.



4. Dihydrogen monoxide diluted in water decomposes in the presence of a catalyst the produce oxygen gas and water.



