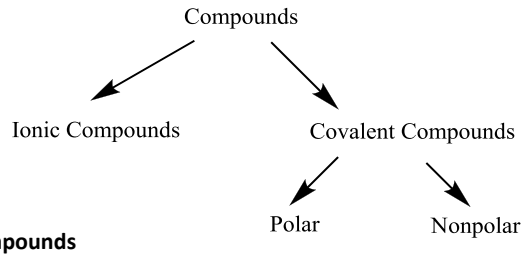
**COMPOUNDS**




**1. Ionic Compounds**

- Ionic compounds are formed from metals and nonmetals by transferring their valance electrons.
- Ionic compounds have ionic bonds.
- They do not conduct electricity in their solid state. Their aqueous solutions conduct electricity.
- They are solids at room conditions.
- They have crystalline structures.
- They generally dissolve in water and produce ions.
- *Example 1*

$Na \longrightarrow Na^{+} + 1e^{-}$

$Cl + 1e^{-} \longrightarrow Cl^{-}$

$Na^{+} + Cl^{-} \longrightarrow NaCl$ (table salt)

Table salt, Magnesium fluoride, Calcium oxide, Silver iodide, Aluminum oxide…etc.

**2. Covalent Compounds**

- Covalent compounds are formed between nonmetals by sharing their valance electrons.
- Covalent compounds have covalent bonds.
  Carbon dioxide. (O=C=O), Water(H-O-H)
- Covalent bonds found between molecules composed of the same atoms are nonpolar covalent bonds.
- Bromine, $Br_2$ (Br-Br)
- Nitrogen gas, $N_2$ (N≡N)
- Oxygen gas, $O_2$ (O=O)
- Covalent bonds between atoms with different nonmetals are called polar covalent bonds.

Ex: HCl HF

- They are composed of nonmetal elements.
- They generally do not conduct electricity, because their molecular structures are conserved while dissolving.
- They can be solid, liquid and gaseous at room conditions.
- *Example 2*
- Water, alcohol, sugar, acetic acid, ozone …etc.

**3. Names of Ions**

- In order to write formula of compounds names of ions should be known.

*Monoatomic Cations (Metal ions)*

| 1 | | 2 | |
|---|---|---|---|
| $H^{+}$ | Hydrogen | $Mg^{+2}$ | Magnesium |
| $Na^{+}$ | Sodium | $Hg^{+2}$ | Mercury (II) |
| $K^{+}$ | Potassium | $Ca^{+2}$ | Calcium |
| $Hg^{+}$ | Mercury | $Cu^{+2}$ | Copper (II) |
| $Ag^{+}$ | Silver | $Ba^{+2}$ | Barium |
| $Cu^{+}$ | Copper | $Ni^{+2}$ | Nickel |
| $Li^{+}$ | Lithium | $Zn^{+2}$ | Zinc |

| 2 | | 3 | |
|---|---|---|---|
| $Fe^{+2}$ | Iron (II) | $Fe^{+3}$ | Iron (III) |
| $Cr^{+2}$ | Chromium (II) | $Cr^{+3}$ | Chromium (III) |

| 2 | | 4 | |
|---|---|---|---|
| $Pb^{+2}$ | Lead (II) | $Pb^{+4}$ | Lead (IV) |
| $Sn^{+2}$ | Tin (II) | $Sn^{+4}$ | Tin (IV) |

*Polyatomic Cations*

| 1 | |
|---|---|
| $NH_4^{+1}$ | Ammonium |
| $H_3O^{+1}$ | Hydronium |

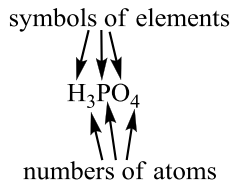
*Monoatomic Anions (Nonmetal ions)*

| -1 | | -2 | |
|---|---|---|---|
| $F^{-}$ | Fluoride | $O^{-2}$ | Oxide |
| $Cl^{-}$ | Chloride | $S^{-2}$ | Sulfide |
| $Br^{-}$ | Bromide | -3 | |
| $I^{-}$ | Iodide | $N^{-3}$ | Nitride |
| $H^{-}$ | Hydride | $P^{-3}$ | Phosphide |

*Polyatomic Anions*

| -1 | | -2 | |
|---|---|---|---|
| $OH^{-1}$ | Hydroxide | $SO_4^{-2}$ | Sulfate |
| $NO_3^{-1}$ | Nitrate | $SO_3^{-2}$ | Sulfite |
| $NO_2^{-1}$ | Nitrite | $CO_3^{-2}$ | Carbonate |
| $CH_3COO^{-1}$ | Acetate | $CrO_4^{-2}$ | Chromate |
| $ClO_2^{-1}$ | Chlorite | $Cr_2O_7^{-2}$ | Dichromate |
| $ClO_3^{-1}$ | Chlorate | $MnO_4^{-2}$ | Manganate |
| $CN^{-1}$ | Cyanide | $C_2O_4^{-2}$ | Oxalate |
| $MnO_4^{-1}$ | Permanganate | | |
| -3 | | | |
| $PO_4^{-3}$ | Phosphate | $PO_3^{-3}$ | Phosphite |

- A formula is a combination of symbols and numbers that represents compounds.




- 3 different elements, H, P and O.
- Contains 3-H, 1-P, 4-O atoms.
- 1 molecule of $H_3PO_4$ contains a total of 8 atoms.

Subscript 1 is not written in the formulas of compounds

***Writing Formulas of Ionic Compounds***

Net charge of ions of a compound must be zero.

***Example 3***

Write the formula of compounds between ions given below.

a. $K^+$ and $Br^-$ b. $Mg^{+2}$ and $O^{-2}$ c. $Ca^{+2}$ and $N^{-3}$

*Solution*

a. KBr b. MgO c. $Ca_3N_2$

***Example 4***

Write the formula of compounds between ions given below.

a. $Li^+$ and $CO_3^{-2}$ b. $Ba^{+2}$ and $NO_3^{-1}$ c. $NH_4^+$ and $P^{-3}$

*Solution*

a. $Li_2CO_3$ b. $Ba(NO_3)_2$ c. $(NH_4)_3P$

***Finding the Oxidation Number of an Element in a Compound***

- Sum of the oxidation numbers of elements in a compound is zero.
- Oxidation numbers of some common ions like $Na^+$, $K^+$, $Li^+$, $Ca^{+2}$, $Ba^{+2}$, $Zn^{+2}$, $Ag^+$, $Al^{+3}$ are constant.
- In general oxygen has -2 oxidation number and hydrogen has +1 oxidation number.

***Example 5***

Find the oxidation number (valency) of C in $Li_2CO_3$.

*Solution*

$\overset{+1}{Li_2}\overset{x}{C}\overset{-2}{O_3}$

2 Li + C + 3 O = 0

2 x (+1) + x + 3 x (-2) = 0

x = +4

***Example 5***

Find the oxidation number (valency) of S in $Al_2(SO_4)_3$.

*Solution*

$\overset{+3}{Al_2}(\overset{x}{S}\overset{-2}{O_4})_3$

2 Al + 3.(S+4.O) = 0

2 . (+3) + 3.{x+4.(-2)} = 0

6 + 3.{x-8} = 0

6 + 3x - 24 = 0

3x = 18

x = +6

**4. Naming Compounds**

***A. Naming Ionic Compounds***

*Name of Metal + Name of Nonmetal ion*

***Example 6***

Name the following ionic compounds.

a. NaBr b. $Al_2O_3$ c. $ZnF_2$ d. $Ba_3N_2$

*Solution*

a. Sodium Bromide b. Aluminum Oxide

c. Zinc Fluoride d. Barium Nitride

***Example 7***

Name the following ionic compounds.

a. KOH b. $NiSO_4$ c. $Zn(MnO_4)_2$ d. $NH_4Cl$

*Solution*

a. Potassium Hydroxide b. Nickel Sulfate

c. Zinc Permanganate d. Ammonium Chloride

***Example 8***

Name the following ionic compounds.

a. $Fe_2O_3$ b. $CuSO_4$ c. $Pb(NO_3)_4$ d. $SnC_2O_4$

*Solution*

a. Iron (III) Oxide b. Copper (II) Sulfate

c. Lead (IV) Nitrate d. Tin (II) oxalate

***B. Naming Molecular Compounds***

*Number + Name of Nonmetal + Number + Name of Nonmetal*

- Greek numbers are used to show the number of atoms.

| | | | |
|---|---|---|---|
| Mono | 1 | Hexa | 6 |
| Di | 2 | Hepta | 7 |
| Tri | 3 | Octa | 8 |
| Tetra | 4 | Nona | 9 |
| Penta | 5 | Deca | 10 |

$Cl_2O_5$

Dichloro Pentoxide

***Example 9***

Name the following molecular compounds.

a. $NO_2$ b. $CCl_4$ c. $N_2O_5$ d. $P_2O_3$

*Solution*

a. Nitrogen dioxide b. Carbon tetrachloride

c. Dinitrogen pentoxide d. Diphosphorus trioxide

***The Law of Definite Proportion (Proust's Law)***

- Proust stated that elements of a compound are combined in definite proportion by mass.

(O=C=O)

$$CO_2 : \frac{m_C}{m_O} = \frac{12}{32} = \frac{3}{8}$$

***Example 10***

Find the definite proportions of elements in the following compounds.

a. $CH_4$ b. $SO_2$ c. KBr

*Solution*

a.

$$CH_4 : \frac{m_C}{m_H} = \frac{12}{4} = \frac{3}{1} = 3$$

b.

$$SO_2 : \frac{m_S}{m_O} = \frac{32}{32} = \frac{1}{1} = 1$$

c.

$$KBr : \frac{m_K}{m_{Br}} = \frac{39}{80}$$