Chemistry M2 Summary

- The revision(95%) is really important

Chemical Names and Formulas

Chemical Formula : *ex: H_2O water

- The chemical formula tells us the number of atoms of each element present in a particle et a substance.

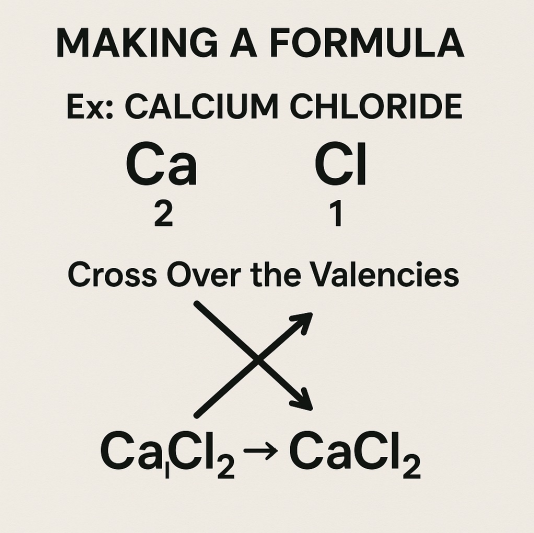
Group to *valency* :

- 1 = 1; 2 = 2; 3 = 3; 4 = 4; 5 = 3; 6 = 2; 7 = 1; 8 = 0

- You avoid +/- (of lons) in using the cross-over method.

Binary Ionic Compound	Binary Molecular(covalent) Compound
• metal ⇒ non-metal **Ex** : $CaCl_2$ (Calcium Chloride)	• non-metal ⇒ non-metal **Ex** : PBr_3 (Phosphorus Tribromide)

Making a formula : *using the Cross-over Method



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Oxidation Numbers

Oxidation Numbers :

- Shows distribution of electrons between atoms.

Rules :

1. **Pure Elements Rule** : The oxidation number of any pure element is always **0** (**O_2 = 0, Fe = 0**).
2. **Monatomic Ions Rule** : The oxidation number of a monatomic ion equals its **charge** (**Na^+ = +1, Cl^- = -1**).
3. **Fluorine Rule** : Fluorine always has an oxidation number of **-1** in compounds (**HF: F = -1, NaF: F = -1**).
4. **Oxygen Rule** : Oxygen usually has an oxidation number of **-2**, except in peroxides (**-1**) and with fluorine (**+2**) (**H_2O: O = -2, H_2O_2: O = -1, OF_2: O = +2**).
5. **Hydrogen Rule** : Hydrogen is **+1** in compounds with nonmetals and **-1** in metal hydrides (**HCl: H = +1, NaH : H = -1**).
6. **Group 1 & 2 Rule** : Group 1 metals are always **+1**, and Group 2 metals are always **+2** in compounds (**NaCl : Na = +1, CaO: Ca = +2**).
7. **Neutral Compound Rule** : The sum of oxidation numbers in a neutral compound must be **0** (**H_2O: H_2 (+1 × 2) + O (-2) = 0**).
8. **Polyatomic Ion Rule** : The sum of oxidation numbers in a polyatomic ion must equal its **charge** (**SO_4^{2-}: S (+6) + O_4 (-2 × 4) = -2**).

Prefix System : *ex : Carbon Monoxide

- uses prefixes to declare the number of atoms, mainly for molecular compound
- does not apply to ionic compounds that include metals with fixed charges.

- **Prefixes** : mono(1), di(2), tri(3), tetra(4), penta(5), hexa(6)

Stock System : *ex : PI_3 -> Phosphorus(III) Iodide

- Uses roman numerals to indicate the oxidation state(charge) of metal ions in ionic compounds.

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Using Chemical Formulas

Formula Mass : *Ex : $H_2O \rightarrow 2(1)+16 = 18$ amu

- Formula mass of any molecule, formula unit, or ion is the sum of the average atomic masses of all atoms represented in its formula.
- Units : amu or u

Molar Mass :

- The molar mass of a substance is equal to the mass in grams de one male, or approximately $6.022x10^{23}$ particles of the substance.
- Units : g/mol

- **NOTE** : Polyatomic Ions are only there for confusion (Ex : PO_4^{3-})

Percentage Composition

Percentage Composition :

- percentage by mass of each element in a compound.

Formula :

$$\frac{\text{mass of element in 1 mol of compound}}{\text{molar mass of compound}} \times 100$$

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Determining Chemical Formulas

Empirical Formula : *simplest form of the "actual" formula

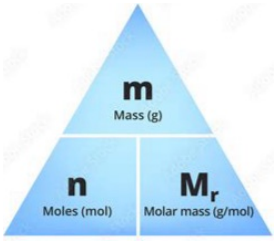
- smallest whole-number mole ratio of the different atoms, in the compound.

Molecular Formula : *it's (double) of the **Empirical Formula**

- "Actual" formula of the compound.
-

Formula :

$$x \cdot (Empirical\ Formula\ mass) = Molecular\ Formula\ mass$$



Examples :

Compound	Type	Empirical Formula
$C_6H_{12}O_6$	Molecular	CH_2O
CH_2O	Empirical	-
C_2H_4	Molecular	CH_2

- **Note** : practice solving the table question.

Describing Chemical Reactions

Chemical Reactions :

- is a process by which one or substances are changed into one or more different substances.

- The **reactant** is the original substance, and **product** is the resulting substance.

Indications of a chemical reaction :

1. Color Change
2. Gas Evolution
3. Formation of participate
4. Heat Change

- You can never change the subscripts of an equation: you can only change coefficients when simplifying/balancing a formula.

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Types of Reactions

Synthesis Reactions :

- two or more substances combine to form a new compound.
- $A + X \rightarrow AX$

Decomposition Reactions :

- a single compound undergoes a reaction that produces two or more simpler substances.
- $AX \rightarrow A + X$

Synthesis Reaction indications :

1. **Reactions of elements with oxygen and sulfur**
   - Elements react with oxygen or sulfur, forming oxides or sulfides.
   - Example: $2Mg + O_2 \rightarrow 2MgO$

2. **Reactions of metals with halogens**
   - Metals combine with halogens, producing metal halides (ionic compounds)
   - Example: $2Na + Cl_2 \rightarrow 2NaCl$

3. **Synthesis reactions with oxides**
   - Oxides react with water or another compound, forming new substances.
   - Example: $CO_2 + H_2O \rightarrow H_2CO_3$

Decomposition Reaction indications :

1. **Decomposition of binary compounds (electrolysis)**
   - A compound splits into elements using electricity.
   - Example: $2H_2O \rightarrow 2H_2 + O_2$ (electrolysis)

2. **Decomposition of metal carbonates**
   - Metal carbonates break into metal oxides and carbon dioxide.
   - Example : $CaCO_3 \rightarrow CaO + CO_2$ (heated)

3. **Decomposition of metal hydroxides**
   - Metal hydroxides decompose into metal oxides and water.
   - Example : $Ca(OH)_2 \rightarrow CaO + H_2O$ (heated)

4. **Decomposition of metal chlorates**
   - Metal chlorates decompose into metal chlorides and oxygen.
   - Example : $2KClO_3 \rightarrow 2KCl + 3O_2$ (heated)

5. **Decomposition of acids**
   - Acids break into nonmetal oxides and water.
   - Example : $H_2CO_3 \rightarrow CO_2 + H_2O$

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Single Displacement Reaction :

- one element replaces a simillar element in a compound.
- A + BX → AB + X

Double Displacement Reaction :

- the ions in 2 compounds exchange places in an aques(dissolving) solution to form two new compounds.
- AX + BY → AY + BX

Single Displacement Reactions

- **Metal Displacement :** A more reactive metal replaces a less reactive metal.
  - *Example :* $2Al+3Pb(NO_3)_2 \rightarrow 3Pb+2Al(NO_3)32Al+3Pb(NO_3)_2 \rightarrow 3Pb+2Al(NO_3)_3$
- **Hydrogen Displacement from Water :**
  - *Most-active metals :* Form hydroxides → $2Na+2H_2O \rightarrow 2NaOH+H_{22}Na+2H_2O \rightarrow 2NaOH+H_2$
  - *Less-active metals :* Form oxides → $3Fe+4H_2O \rightarrow Fe_3O_4e+4H_{23}Fe+4H_2O \rightarrow Fe_3O_4+4H_2$
- **Hydrogen Displacement from Acid :** Produces salt and **hydrogen gas**.
  - *Example :* $Mg+2HCl \rightarrow H_2+MgCl_2Mg+2HCl \rightarrow H_2+MgCl_2$
- **Halogen Displacement :** A more reactive halogen replaces a less reactive one.
  - *Trend :* **$F_2 > Cl_2 > Br_2 > I_2$**
  - *Examples :*
    - $Cl_2+2KBr \rightarrow 2KCl+Br_2Cl_2+2KBr \rightarrow 2KCl+Br_2$
    - $F_2+2NaCl \rightarrow 2NaF+Cl2F_2+2NaCl \rightarrow 2NaF+Cl_2$
    - $Br_2+KClBr_2+KCl$ → **No reaction**

Double Displacement Reactions

- **Formation of a Precipitate :** An insoluble compound forms.
  - *Example :* $2KI+Pb(NO_3)_2 \rightarrow PbI_2(s)+2KNO_{32}KI+Pb(NO_3)_2 \rightarrow PbI_2(s)+2KNO_3$
- **Formation of a Gas :** A gas is released as a reaction product.
  - *Example :* $FeS+2HCl \rightarrow H_2S+FeCl_2FeS+2HCl \rightarrow H_2S+FeCl_2$
- **Formation of Water (Neutralization) :** An acid reacts with a base to form water and salt.
  - *Example :* $HCl+NaOH \rightarrow NaCl+H2OHCl+NaOH \rightarrow NaCl+H$

Combustion Reaction :

- a substance combines with oxygen, releasing a large amount of energy in the form of light & heat.

- it's indicated when oxygen is combined in a compound in the reactants
  - $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$

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Activity Series

Activity Series : *for single-displacement reactions

- is a list of elements organized according to the ease with which the elements undergo certain chemical reactions.

- metals are more reactive because of lesser "electronegativity" , while non-metals are less reactive.

The Activity Series : *really important to memorize

- **Just remember** : when a reaction occurs, displacement takes place, and more reactive replace less reactive.