SCH 3U
SYNTHESIS & DECOMPOSITION REACTIONS

Chemical reactions are classified according to a polychotomy – division or separation into many types or parts.

PART A: SYNTHESIS REACTIONS: aka. combination or formation reactions

- 2 or more elements or compounds combine to form a new substance.
- A + B → C

TYPES of Synthesis Reactions:

1. element + element → binary compound

- Metal or a non-metal reacting with oxygen produces an **oxide**...
  …also known as **combustion**… see Part C on next page.

  Eg. $C + O_2 \rightarrow CO_2$

  $Mg + O_2 \rightarrow MgO$

- Metal with a non-metal forms a binary compound of these elements.

  Eg. $Mg + Br_2 \rightarrow MgBr_2$

2. compound + compound → polyatomic compound

- **Acidic oxide + water → acid**
  (non-metal oxide)

  Eg. $CO_2 + H_2O \rightarrow H_2CO_3$

- **Basic oxide + water → base**
  (metal oxide)

  Eg. $CaO + H_2O \rightarrow Ca(OH)_2$

- **Acidic oxide + basic oxide → polysalt**

  Eg. $CO_2 + CaO \rightarrow CaCO_3$

PART B: DECOMPOSITION REACTIONS: opposite of Synthesis reactions

- A compound breaks down into elements or other compounds.
- C $\rightarrow$ A + B

TYPES of Decomposition Reactions:

1. **binary compound $\rightarrow$ element + element**

   Eg. $H_2O \rightarrow H_2 + O_2$

2. **acid $\rightarrow$ acidic oxide + water**

   Eg. $H_3PO_4 \rightarrow P_2O_5 + H_2O$

3. **base $\rightarrow$ basic oxide + water**

   Eg. $Fe(OH)_3 \rightarrow Fe_2O_3 + H_2O$

4. **polysalt $\rightarrow$ acidic oxide + basic oxide**

   Eg. $MgSO_3 \rightarrow MgO + SO_2$

PART C: COMBUSTION REACTIONS: special synthesis reactions

- **Complete combustion reactions: reactions of elements or compounds with O_2**
- Common oxides of the elements/compounds are formed.
- Carbon-containing compounds, such as CH_4 and C_2H_5OH, combust to form CO_2 and H_2O.

  Eg. $C_2H_5OH + O_2 \rightarrow CO_2 + H_2O$ [with excess oxygen]

- Sulfur-containing compounds combust to form sulfur oxides, such as SO_2, which is a precursor to acid rain.
- **Incomplete combustion** is the result of a lack of O_2, in which case other biproducts are formed. For instance, the incomplete combustion of a carbon-containing compound produces CO and water. CO is a deadly gas.

  Eg. $C_2H_5OH + O_2 \rightarrow CO_2 + CO + H_2O$ [incomplete combustion]

ADDENDUM:

ACIDS – A substance that begins with hydrogen tends to be acidic.

Eg. HF is an acid because it begins with H – known as hydrofluoric acid
H_2CO_3 is an acid – known as carbonic acid
H_2SO_4 is an acid – known as sulfuric acid

Exceptions: organic acids often end with H, such as CH_3COOH (acetic acid)

BASES – A substance that ends with the hydroxide (-OH) group. There are bases which do not have the hydroxide group; these bases are discussed in a later chapter.

Eg. NaOH – sodium hydroxide is a base.
$Mg(OH)_2$ – magnesium hydroxide is a base.