Synthesis Reactions

A + B → AB

Definition

- A compound is formed between:
  - Two elements
  - An element and a compound
  - Two compounds

Examples

$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$

Write two additional examples of synthesis reactions.

$Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$

$CO_2(g) + H_2O(l) \rightarrow H_2CO_3(aq)$

Decomposition Reactions

AB → A + B

Definition

- Compound breaks apart to create:
  - Two elements
  - One or more elements and/or compounds
  - Two or more compounds

Examples

$H_2CO_3(aq) \rightarrow H_2O(l) + CO_2(g)$

Write two additional examples of decomposition reactions.

$C_{12}H_{22}O_{11}(s) \rightarrow H_2O(g) + C(s)$

$2Ag_2O(s) \rightarrow 4Ag(s) + O_2(g)$

Single Replacement

A + BC → AC + B

Definition

- Involves the substitution of one element for another in a compound
- **Activity series**: the more active elements appear higher in the series and will replace less active elements, appearing lower in the series
- Also known as single *displacement* reactions

Examples

$CuSO_4(aq) + Zn(s) \rightarrow Cu(s) + ZnSO_4(aq)$

Predict the products. If no reaction, write NR.

$Ni(NO_3)_2(aq) + Mg(s) \rightarrow Ni(s) + Mg(NO_3)_2(aq)$

$AlSO_4(aq) + Pt(s) \rightarrow NR$

$Cl_2(g) + 2KI(aq) \rightarrow I_2(s) + 2KCl(aq)$

$I_2(s) + 2NaF(aq) \rightarrow NR$

Double Replacement

AB + CD → AD + CB

Definition

- Two compounds react to form two new compounds by exchanging anions
- Reactants are ionic compounds or acids, usually in aqueous solution
- Insoluble products will precipitate out of solution (form a solid)
- Also known as double *displacement* reactions

Examples

$Ca(OH)_2(aq) + 2HCl(aq) \rightarrow CaCl_2(s) + 2H_2O(l)$

$3NaOH + FeCl_3 \rightarrow 3NaCl + Fe(OH)_3$

Predict the products.

$AgNO_3(aq) + KCl(aq) \rightarrow AgCl(s) + KNO_3(aq)$

$Na_2SO_4(aq) + BaCl_2(aq) \rightarrow 2NaCl(aq) + BaSO_4(s)$

Combustion Reactions

$A + O_2 \rightarrow AO$

Definition

- Oxygen is a reactant and an oxide is produced
- Energy is released in the forms of heat and light

Examples

$4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s)$
$2Mg(s) + O_2(g) \rightarrow 2MgO(s)$
$2Al(s) + 3O_2(g) \rightarrow 2Al_2O_3(s)$

Combustion of Hydrocarbons

Hydrocarbon + $O_2(g) \rightarrow CO_2(g) + H_2O(g)$

Definition

- Hydrocarbons in fossil fuels are combined with oxygen at high temperatures (burning of a fuel)
- Always produces carbon dioxide and water vapor

Examples

Combustion of methane
$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$

Combustion of ethane
$2C_2H_6(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(g)$

Combustion of propane
$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g)$

Combustion of butane
$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(g)$

Neutralization

- Reaction of an acid with a base to produce an ionic salt and water (double replacement)

Acid + Base → Water + Salt
$HCl + NaOH \rightarrow H_2O + NaCl$

Predict the products:
$HClO + KOH \rightarrow H_2O + KClO$
$HNO_3 + NaOH \rightarrow H_2O + NaNO_3$
$H_2SO_4 + Mg(OH)_2 \rightarrow 2H_2O + MgSO_4$

Condensation Reactions

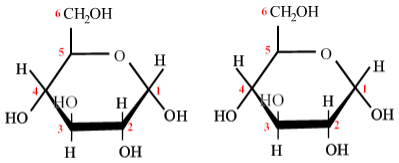
Definition

- Two small organic molecules combine to form a complex macromolecule (synthesis)
- Accompanied by the loss of a small molecule, such as water or ammonia

Examples

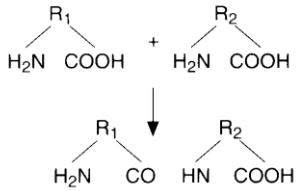
<u>Carbohydrate Formation</u>

- Complex carbohydrates (polysaccharides) are polymers of simple sugars (monosaccharaides)



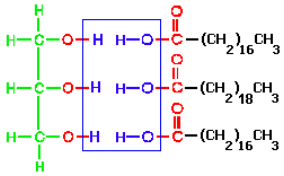
<u>Protein Formation</u>

- Proteins are long chains of amino acids (contain amine groups involving nitrogen) joined by peptide bonds forming polypeptides



<u>Lipid Formation</u>

- the formation of lipids (triglycerides) from three fatty acids and glycerol



Photosynthesis

- complex process that converts energy from sunlight to chemical energy in the bonds of carbohydrates
- Occurs in plants and some algae, taking place in chloroplasts involving chlorophyll
- complementary process of respiration

$6CO_2 + 6H_2O + \text{sunlight} \rightarrow C_6H_{12}O_6 + 6O_2$