Synthesis and Decomposition Reactions

For each of the following reactions, the left-to-right reaction is the synthesis and the right-to-left reaction is the decomposition.

General

element + element $\rightleftharpoons$ binary compound

Example: $2\,\mathrm{P\,(s)} + 3\,\mathrm{Cl_2\,(g)} \rightleftharpoons 2\,\mathrm{PCl_3\,(g)}$

Ionic Compounds

$$\text{metal} + \mathrm{O_2} \rightleftharpoons \text{metallic oxide} \begin{cases} \rightleftharpoons \text{metallic oxide} + \mathrm{H_2O} \rightleftharpoons \text{metallic hydroxide} \\ \rightleftharpoons \text{metallic oxide} + \mathrm{CO_2} \rightleftharpoons \text{metallic carbonate} \end{cases}$$

Example:

$$\mathrm{Mg\,(s)} + \tfrac{1}{2}\,\mathrm{O_2\,(g)} \rightleftharpoons \mathrm{MgO\,(s)} \begin{cases} \rightleftharpoons \mathrm{MgO\,(s)} + \mathrm{H_2O\,(\ell)} \rightleftharpoons \mathrm{Mg(OH)_2\,(s)} \\ \rightleftharpoons \mathrm{MgO\,(s)} + \mathrm{CO_2\,(g)} \rightleftharpoons \mathrm{MgCO_3\,(s)} \end{cases}$$

metal + nonmetal $\rightleftharpoons$ "____ide" salt + $\mathrm{O_2} \rightleftharpoons$ "____ate" compound

Example: $2\,\mathrm{Na\,(s)} + \mathrm{Cl_2\,(g)} \rightleftharpoons 2\,\mathrm{NaCl\,(s)} + 3\,\mathrm{O_2\,(g)} \rightleftharpoons 2\,\mathrm{NaClO_3\,(s)}$

Molecular Compounds

nonmetal + $\mathrm{O_2} \rightleftharpoons$ nonmetallic oxide $+\mathrm{H_2O} \longrightarrow$ acid

Example: $\mathrm{C\,(s)} + \mathrm{O_2\,(g)} \rightleftharpoons \mathrm{CO_2\,(g)} + \mathrm{H_2O\,(\ell)} \rightleftharpoons \mathrm{H_2CO_3\,(aq)}$

ammonia compounds

$\mathrm{N_2\,(g)} + 3\,\mathrm{H_2\,(g)} \rightleftharpoons 2\,\mathrm{NH_3\,(g)} + 2\,\mathrm{H_2O\,(\ell)} \rightleftharpoons 2\,\mathrm{NH_4OH\,(aq)}$