Introduction to Chemical Reactions

Types of Reactions

Synthesis Decomposition Single Displacement (or Replacement) Double Displacement (or Replacement)

Synthesis Reactions

One of the most important activities in chemistry is the synthesis of new compounds.

When a given compound is formed from simpler materials, we call this a synthesis reaction.



Examples of synthesis reactions: $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$

$C(s) + O_2(g) \rightarrow CO_2(g)$

Ways to Classify Reactions

Decomposition Reactions

In many cases a compound can be broken down into simpler compounds or all the way to the component elements.

This is usually accomplished by heating or by the application of an electric current. Such reactions are called decomposition reactions.



Examples of decomposition reactions:

 $2 H_2O(I) \xrightarrow{\text{Electric}} 2 H_2(g) + O_2(g)$ $2 H_2O(I) \xrightarrow{\text{Current}} 2 H_2(g) + O_2(g)$ $2 NaCI(I) \xrightarrow{\text{Electric}} 2 Na(I) + CI_2(g)$

A decomposition reaction is just the opposite of the synthesis reaction.

Zn (s) + 2HCl (aq) \rightarrow H₂ (g) + ZnCl₂ (aq) this reaction is classified based on the fact that a *single* type of anion (Cl⁻) has been exchanged between H⁺ and Zn²⁺.

That is, Cl⁻ is originally associated with H⁺ in HCl and ends up associated with Zn²⁺ in the product ZnCl₂.



Zn (s) + 2HCl (aq) \rightarrow H₂ (g) + ZnCl₂ (aq) We can call this a single-replacement reaction

We can represent a single replacement as

$A + BC \rightarrow B + AC$



 $K_2CrO_4(aq)$ + Ba(NO₃)₂ (aq) → 2KNO₃ (aq) + BaCrO₄ (s)

- In this reaction the 2 anions (NO_{3⁻} and CrO₄ ²⁻) are simply exchanged.
 - CrO_4^{2-} was originally associated with K⁺ in K_2CrO_4 and NO_3^- was associated with Ba^{2+} in $Ba(NO_3)_2$.

 $2 \mathbb{K}_2 \mathbb{C}^{0}$ $\longrightarrow \mathbb{B}(\mathbb{N}^{0})^{2}$ In the products these associations are

reversed.

 $K_2CrO_4(aq)$ + Ba(NO₃)₂ (aq) → 2KNO₃ (aq) + BaCrO₄ (s)

Because of this double exchange, call this reaction a double-exchange reaction or double-displacement reaction.

We might represent such a reaction as $AB + CD \rightarrow AD + CB$



Classifying Reactions

Classify the following reaction $S_8(s) + 8O_2(g) \rightarrow 8SO_2(g)$

Solution

This is a synthesis reaction (elements combine to form a compound)

Classifying Reactions

Classify the following reaction 2AI (s) + $3CI_2(g) \rightarrow 2AICI_3(s)$

Solution This is a synthesis reaction

Classifying Reactions

Classify the following reaction $2AIN(s) \rightarrow 2AI(s) + N_2(s)$ Solution

This is a decomposition reaction (a compound breaks down into elements)

Classifying Reactions

Classify the following reaction

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

Solution

This is double displacement reaction in which the anions Cl⁻ and SO₄²⁻ are exchanged.

Classifying Reactions

Classify the following reaction $2K_{(s)} + 2H_2O_{(I)} ---> H_{2(g)} + 2KOH_{(aq)}$ Solution

This is a single replacement reaction in which the anion O^{2-} is exchanged between H_2O and KOH.

