Decomposition reactions

A decomposition reaction occurs when one reactant breaks down into two or more products. This can be represented by the general equation: **AB → A + B**.

AB is the reactant, A and B are the products.

During a decomposition reaction, the bonds between the atoms break down in the starting substance. The atoms then rearrange to form new bonds, resulting in new substances with properties different from the starting material.
A reaction is also considered to be a decomposition reaction even when one or more of the products are still compounds.
Most decomposition reactions require an input of energy in the form of heat, light, or electricity.

Examples of decomposition reactions include:

- The breakdown of hydrogen peroxide to water and oxygen; it occurs quicker with a catalyst (*catalytic* decomposition) such as manganese dioxide or an enzyme called catalase.

  hydrogen peroxide → water + oxygen

  $2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$

- Metal hydroxides decompose on heating. This is *thermal* decomposition.

  metal hydroxide → metal oxide + water

  copper hydroxide → copper oxide + water

  $Cu(OH)_2(s) \rightarrow CuO(s) + H_2O(l)$

- Some metal carbonates decompose on heating. This is *thermal* decomposition.

  metal carbonate → metal oxide + water + carbon dioxide

  calcium carbonate → calcium oxide + water + carbon dioxide

  $CaCO_3(s) \rightarrow CaO(s) + H_2O(l) + CO_2(g)$

  This is an important reaction in the production of calcium oxide, CaO, which is then used to make cement.

- Some unstable acids decompose to produce nonmetal oxides and water. Carbonic acid decomposes easily at room temperature.

  carbonic acid → water + carbon dioxide

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

  Carbonated (fizzy) drinks like Coca Cola contain carbonic acid which decomposes into H_2O and CO_2 when opened, causing the drink to 'go flat' over time as the CO_2 bubbles escape.

- When *uv* light falls on unstable silver bromide, *photochemical* decomposition occurs

  silver bromide → silver + bromine

  $2AgBr(s) \rightarrow 2Ag(s) + Br_2(l)$

  Photographic films have a coating of silver bromide, which on exposure to light splits into silver and bromine. More silver is deposited where the film was exposed to more light, creating the photographic negative.

- When an electric current is passed through water it decomposes into its elements. This is *electrolytic* decomposition.

  water → hydrogen + oxygen

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

- A very useful decomposition reaction inflates an airbag when a car accident occurs.

  sodium azide → sodium + nitrogen

  $2NaN_3(s) \rightarrow 2Na(s) + 3N_2(g)$

  The nitrogen gas is a great way to inflate an airbag as a small amount of solid sodium azide turns into a large volume of nitrogen gas. As sodium metal is very reactive and potentially explosive the airbags also contain some KNO_3 and SiO_2 to convert it quickly to harmless compounds.

- Ammonium dichromate decomposes on heating.

  Ammonium dichromate → chromium(III) oxide + nitrogen + water

  $(NH_4)_2Cr_2O_7(s) \rightarrow Cr_2O_3(s) + N_2(g) + 4H_2O(l)$

  This reaction was popular in a 'model volcano' demonstration, no longer used due to safety considerations.

Test yourself

1. What is a decomposition reaction?

2. What is usually needed for a decomposition reaction to take place?

3. Are elements always the product of a decomposition reaction?

4. How does the reaction that occurs in an airbag, $2NaN_3(s) \rightarrow 2Na(s) + 3N_2(g)$, demonstrate the conservation of mass?

5. Why can this reaction be classified as a decomposition reaction?

$$2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$$

What is the Opposite of 'Decomposition Reaction'?

The opposite of a decomposition reaction is a synthesis or **combination reaction**. Such reactions involve the formation of a single product from two or more reactants.