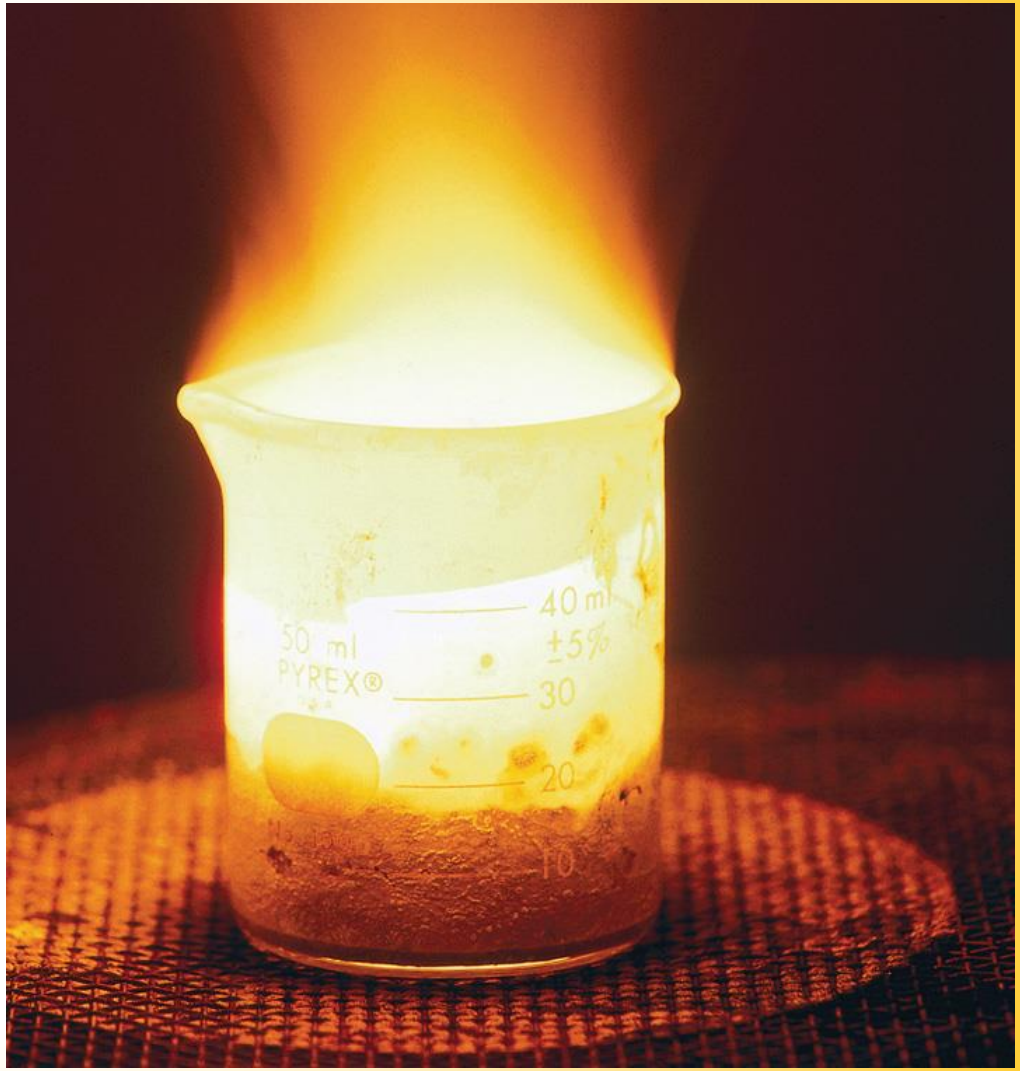
Types of Chemical Reactions: Synthesis & Decomposition Reactions



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There are millions of chemical reactions that are known to occur. Among these millions of reactions, certain types display similar characteristics. As a result, chemists are able to group reactions into 4 basic types to help organize these known reactions and to help chemists predict the products of unknown reactions.

Synthesis

Decomposition

Single Displacement

Double Displacement

Click to learn about synthesis reactions

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Synthesis Reactions

In a synthesis reaction, two or more small reactants combine to form one larger product. The general formula for a synthesis reaction can be written as follows:

Click for the General Formula for a Synthesis Reaction

Synthesis Reactions

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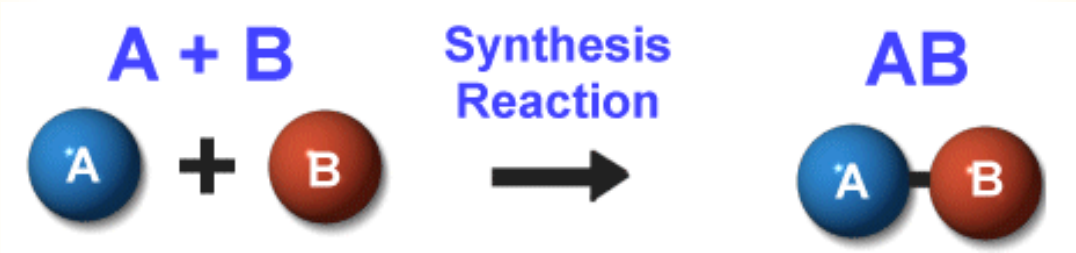
In a synthesis reaction, two or more simpler reactants combine to form one larger product. The general formula for a synthesis reaction can be written as follows:



Where A and B are the reactants, and they combine to form AB, the product. For a synthesis reaction to occur, the two reactant molecules must collide with each other, break any existing bonds between their atoms and form new bonds.

Synthesis Reaction Example

Synthesis Reactions

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A good example of a synthesis reaction occurs when diatomic molecules of hydrogen gas ($H_{2\,(g)}$) burn in the air, combining with diatomic molecules of oxygen gas ($O_{2\,(g)}$) to form water. Try to write out the **balanced** chemical equation for this reaction and you will see the general formula for a synthesis reaction represented.

Balanced Synthesis Reaction Equation

Synthesis Reactions

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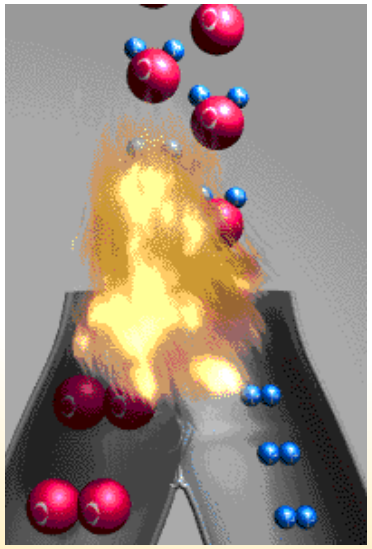
A good example of a synthesis reaction occurs when diatomic molecules of hydrogen gas burn in the air, combining with diatomic molecules of oxygen gas to form water.

$$2H_{2\,(g)} + O_{2\,(g)} \rightarrow 2H_2O_{\,(l)}$$

As you can see from the reaction equation, the two reactant molecules combine to form one more complex molecule. The animation below represents this synthesis reaction occurring, as hydrogen and oxygen molecules react to form water molecules.



Test Your Understanding

Test your understanding:

Which of the following reactions is a synthesis reaction? (Click the box with the correct answer.)

$CO_2 + H_2O \rightarrow H_2CO_3$

$C_2H_8 + O_2 \rightarrow 2CO_2 + 4H_2O$

$2Fe + 6NaBr \rightarrow 2FeBr_3 + 6\ Na$

$2HCl \rightarrow H_2 + Cl_2$

Incorrect. Try again:

Which of the following reactions is a decomposition reaction? (Click the box with the correct answer.)

$CO_2 + H_2O \rightarrow H_2CO_3$

$C_2H_8 + O_2 \rightarrow 2CO_2 + 4H_2O$

$2Fe + 6NaBr \rightarrow 2FeBr_3 + 6\ Na$

$2HCl \rightarrow H_2 + Cl_2$

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Correct

In the reaction:

$$CO_2 + H_2O \rightarrow H_2CO_3$$

Two simple reactants combine to form one complex product molecule, indicating a synthesis reaction has taken place.

The next type of reaction we will explore is the opposite of a synthesis reaction, known as a decomposition reaction.

Decomposition Reactions

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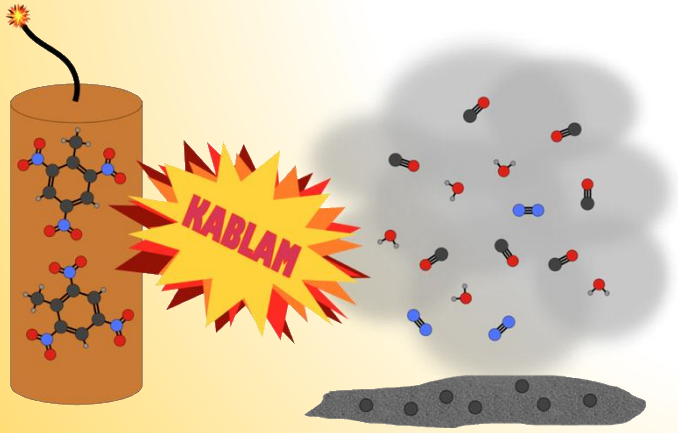
Decomposition Reactions

In a decomposition reaction, one large reactant compound breaks down (or decomposes) into two or more smaller substances. A decomposition reaction is the opposite of a synthesis reaction. Using this information, try to write a general formula for a decomposition reaction before clicking the button below.



Click for the General Formula for a Decomposition Reaction

Decomposition Reactions

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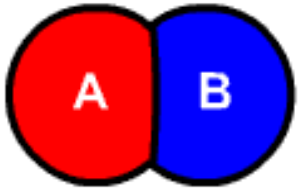
In a decomposition reaction, one large reactant compound breaks down (or decomposes) into two or more smaller substances. The general formula for a decomposition reaction can be written as follows:

Where the compound AB is the reactant which decomposes into the products A and B.



More on Decomposition Reactions

Decomposition Reactions

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Reactants in a decomposition reaction can decompose into simple elements, more complex compounds or combinations of the two.

For example, simple ionic compounds often decompose into their more simple elemental forms. Potassium chloride (KCl) decomposes into solid potassium (K) and chloride gas (Cl_2) when electricity is used to provide energy. Write the balanced reaction equation for this reaction.

Decomposition of KCl

Decomposition Reactions

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Reactants in a decomposition reaction can decompose into simple elements, more complex compounds or combinations of the two. For example, potassium chloride (KCl) decomposes into solid potassium and chloride gas when electricity is used to provide energy.

$$2KCl_{(s)} \rightarrow 2K_{(s)} + Cl_{2\,(g)}$$

Other decomposition reactions involve the breakdown of reactants into both elements and compounds, such as the decomposition of potassium chlorate ($KClO_3$) into potassium chloride ($KCl_{(s)}$) and oxygen gas ($O_{2\,(g)}$)

More Decomposition Reactions

Decomposition Reactions

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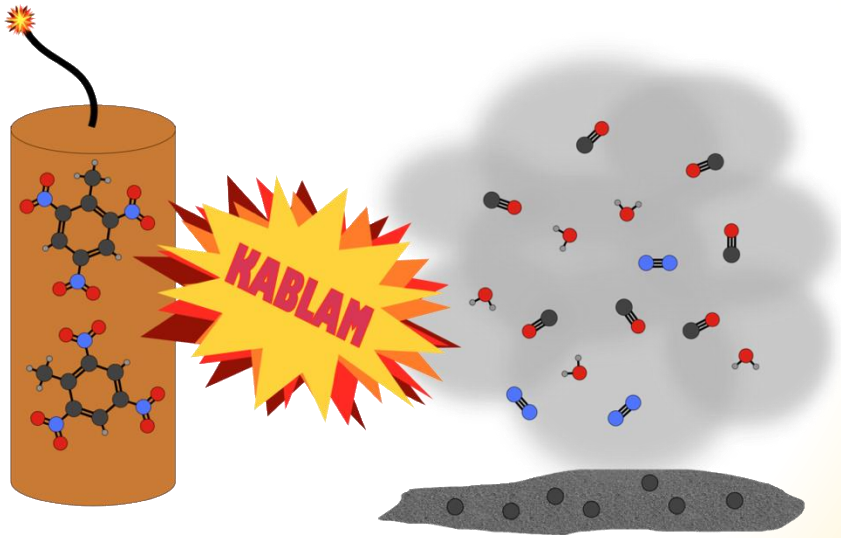
Decomposition reactions are used in many types of explosives such as TNT. Typically, for a decomposition reaction to occur, energy is needed to get the reaction started, this is why, for example, for a stick of TNT to explode a fuse must be lit. This fuse provides the energy to allow the decomposition reaction to begin, resulting in a flaming explosion.



Pharaoh's Serpent – Decomposition Reaction

Decomposition Reactions

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A good example of a decomposition reaction is commonly referred to as the pharaoh's serpent reaction in which a white powder made up of mercury thiocyanate is ignited resulting in a visually stunning decomposition reaction.

Click to view the Pharaoh's Serpent Reaction

Decomposition Reactions

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A good example of a decomposition reaction is commonly referred to as the pharaoh's serpent reaction in which a white powder made up of mercury thiocyanate is ignited resulting in a visually stunning decomposition reaction.

Click for the Reaction Equation

Decomposition Reactions

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In the pharaoh's serpent reaction the large, complex molecule mercury thiocyanate, ($Hg(SCN)_2$) decomposes into carbon nitride (C_3N_4), mercury sulfide (HgS) and carbon disulfide (CS_2) when energy is provided in the form of a flame or spark. Try to write the balanced equation for this reaction on your own, then click the button below to view it.

Pharaoh's Serpent Reaction Equation

Decomposition Reactions

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In the pharaoh's serpent reaction the large, complex molecule mercury thocyanate, ($Hg(SCN)_2$) decomposes into carbon nitride (C_3N_4), mercury sulfide (HgS) and carbon disulfide (CS_2) when energy is provided in the form of a flame or spark. Try to write the balanced equation for this reaction on your own, then click the button below to view it.

$$2Hg(SCN)_2 \rightarrow 2HgS + CS_2 + C_3N_4$$

You should notice in this reaction equation, one large molecule decomposes into several smaller substances, identifying it as a decomposition reaction.

Test Your Understanding

Test your understanding:

Which of the following reactions is a decomposition reaction? (Click the box with the correct answer.)

$P_4 + 5O_2 \rightarrow 2P_2O_5$

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

$2Al + 3Br_2 \rightarrow 2AlBr_2$

$2HCl \rightarrow H_2 + Cl_2$

Incorrect. Try again:

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$2Al + 3Br_2 \rightarrow 2AlBr_2$

$2HCl \rightarrow H_2 + Cl_2$

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Correct

In the reaction:

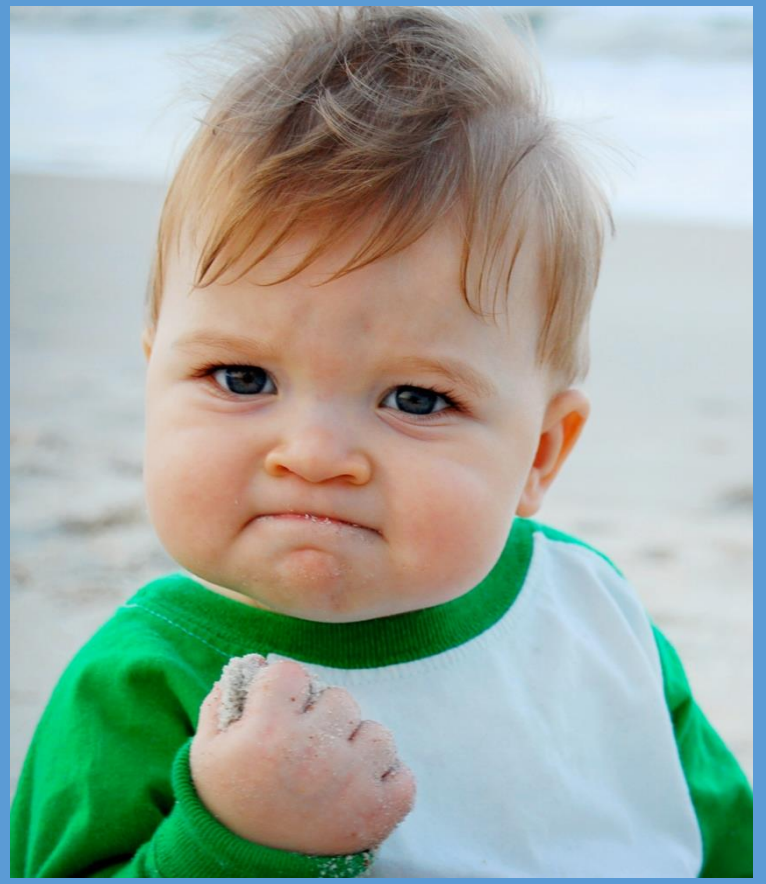
$$2HCl \rightarrow H_2 + Cl_2$$

One reactant breaks down into 2 smaller substances, indicating a decomposition reaction has taken place.

Success Criteria

Success!

You have reached the end of this activity. You will know that you have achieved the goals for this activity when you can describe and identify synthesis and decomposition reactions and can give examples of different types of these reactions.



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