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Abstract:	A chemical reaction occurs when chemicals combine and change. The starting substances of a chemical reaction are reactants and the new substances are products. A catalyst is a chemical that changes the speed of a reaction, but does not change itself. Oxidation and reduction, exothermic and endothermic reactions are kinds of chemical reactions. Various types of chemists study chemistry and chemical reactions. (Copyright applies to all Abstracts)
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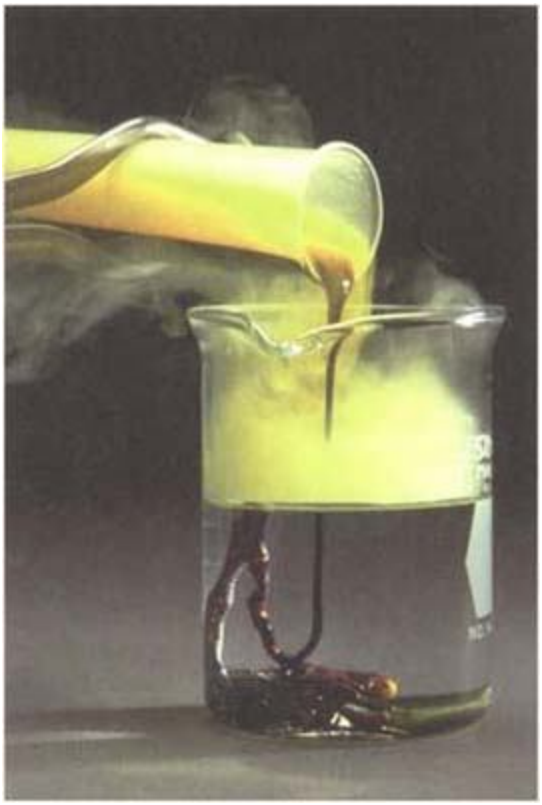
Reactions

A chemical reaction occurs when chemicals combine and change. Reactions are constantly taking place. Many occur in nature. Some reactions take place inside animals and plants. The food that humans and other animals eat is digested in a series of chemical reactions. Photosynthesis is a series of chemical reactions in plants. Other reactions are caused by humans. Reactions take place every day in laboratories and factories. Chemical reactions take place above the surface of the Earth. Some of these reactions protect the Earth from harmful ultraviolet radiation. Chemical reactions make all life possible.



Chemical Reaction

There are many different ways that chemicals combine, or react. A chemical reaction occurs when one substance is broken apart and put together as a new substance. The starting substances are called reactants (ree-ACK-tuntz).

The new substances are called products. All chemical reactions cause atoms and molecules to be rearranged. Sometimes, other chemicals can be used to speed up reactions. Reactions also release some form of energy.

All chemical reactions involve making and breaking bonds between atoms. Chemical bonds are pulled apart and put back together every time a chemical reaction takes place. The reactants are broken into ions once a reaction begins. These ions rearrange themselves into a new substance or substances. Energy is required for bonds to break. This energy can take many forms. Some chemical reactions take place when there is heat. Other reactions need electricity to get started. A few reactions take place with light.

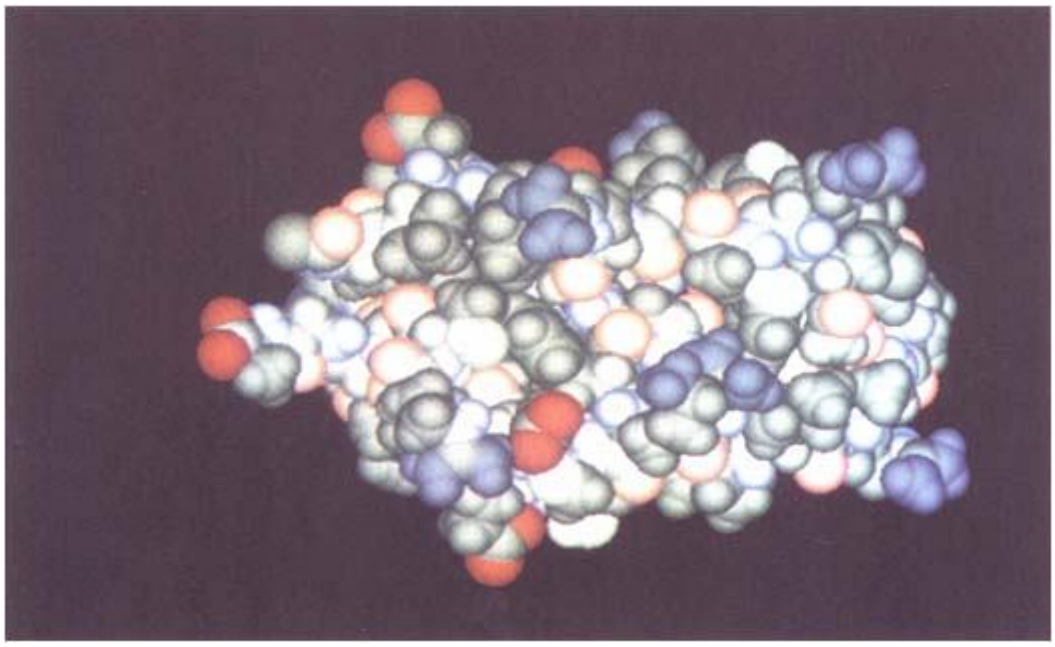
All chemical reactions conserve mass. This means that the amount of atoms at the beginning of a reaction is the same as the amount of atoms at the end of a reaction. The atoms are just rearranged. The number of atoms is the same on both sides of a chemical equation. The total mass of the reactants is the same as the mass of the products.

Catalysts

A catalyst (KAH-tul-ust) is a chemical that changes the speed of a reaction. The catalyst does not change in the reaction. Some catalysts are a single substance. Other catalysts are a combination of many substances. Catalysts do not start reactions. Most catalysts speed up reactions. Inhibitors (in-HIH-buh-turz) are catalysts that slow down reactions. Some inhibitors cause other catalysts to stop working.

Catalysts help do many different things. They can allow reactions to happen at lower temperatures. Some catalysts help bring reactants close together. In manufacturing,

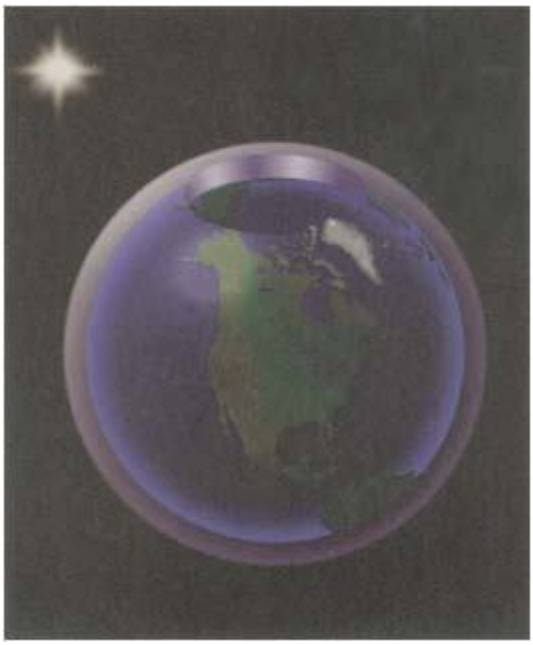
they are used to produce gasoline, rubber, and medicine. Catalysts can be used over again since they remain at the end of a reaction. This helps save companies money.



Computer model of an enzyme.

Enzymes (EN-zymz) are catalysts made by living cells. They help speed up chemical reactions in the human body. Each enzyme will work in only one type of reaction. Enzymes help digest food in the body in only a few hours. Digestion would take several weeks without enzymes. Enzymes also help the body produce proteins and other important chemicals.

Catalysts in the Earth's atmosphere are causing the ozone layer to break down. Ozone protects the Earth from harmful ultraviolet rays from the Sun. Chlorine is a catalyst in the upper atmosphere. The chlorine comes from chlorofluo-rocarbons (klor-oh-flor-oh-KAR-bunz), or CFCs, that are released into the atmosphere. Chlorine allows ozone to break down into oxygen. The chlorine remains and keeps destroying ozone. This has caused a hole in the ozone layer. Governments around the world have banned the production of CFCs.

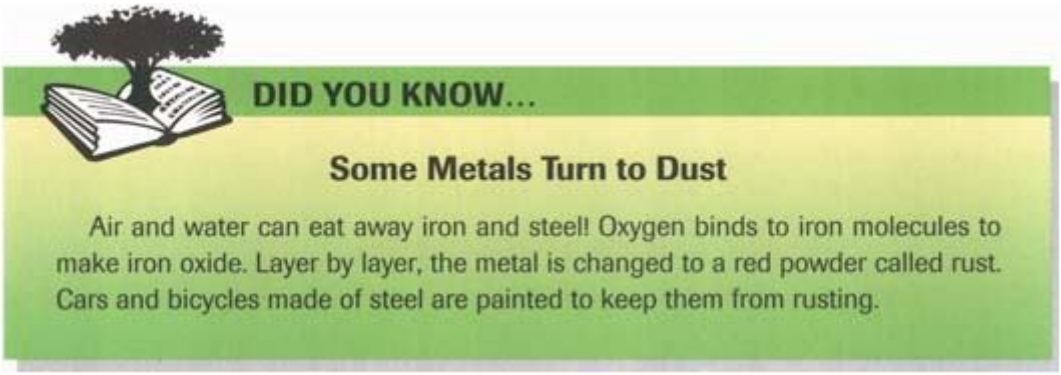


A hole in the ozone layer allows dangerous solar radiation to reach the surface of the Earth.

Oxidation and Reduction

Whenever a molecule takes UP oxygen, something else has to give up oxygen. A substance that combines with oxygen or loses hydrogen becomes oxidized (AWK-suh-dized). The substance that loses oxygen or gains hydrogen is reduced. Oxidation (awk-suh-DAY-shun) and reduction (rih-DUCK-shun) always go together. They can also take place between the electrons of two atoms. This is called electron transfer. Atoms that lose electrons are oxidized. Atoms that gain electrons are reduced.

Rust covers a steel beam of an old train station.



DID YOU KNOW: Some Metals turn to Dust

Many different kinds of chemical processes use oxidation and reduction. Food that gets old oxidizes and goes bad. Keeping food refrigerated slows down the rate of oxidation. Humans and animals also rely on this reaction. The food people and animals eat is oxidized in the cells. This helps give the body energy. Margarine (MAR-juh-run) is made by reducing oil. Hydrogen is combined with the oil in a process called hydrogenation (hi-draw-juh-NAY-shun).

A weak, or diluted (di-LOO-ted), solution of hydrogen peroxide (puh-RAWK-side) is a common reducing agent. The chemical formula for hydrogen peroxide is H[SUB2]O [SUB2]. It becomes water and oxygen when it is reduced. A solution of hydrogen peroxide and water is often used to kill germs. Bleach sometimes contains stronger solutions of hydrogen peroxide. Bleaching is a process that removes color from cotton and wool. It is often used to make clothes whiter.

Combustion takes place in the engines of the Space Shuttle.

Fires are common oxidation reactions. Fire consumes a lot of oxygen because the material that is burning is oxidized at a very fast rate. Flames are seen because the reaction energy is so intense. Fires need oxygen, heat, and fuel. Materials cannot burn when there is no oxygen.

Combustion (kuru-BUS-chun) is a form of burning that helps to drive motors, propel airplanes, and launch rockets. Rockets in outer space must carry oxygen in their fuel in order for combustion to take place. Gasoline engines are sometimes called combustion engines. Gasoline is burned inside the engine. The oxidation reaction releases energy that makes the car move.

GETTING TO KNOW...

Antoine-Laurent Lavoisier

Antoine-Laurent Lavoisier (lah-vwah-ZYAY) was born in France in 1743. His father and grandfather were lawyers, so he became a lawyer too. But Lavoisier was more interested in science.

Lavoisier wanted to make chemistry a separate science. He began to experiment with combustion. Some scientists believed that burning released a material called **phlogiston** (flo-JIS-tun). Lavoisier discovered that phlogiston does not exist. He also showed that air and water are compounds. He proved that many elements can occur in different phases—as solids, liquids, or gases. Lavoisier came up with the names "oxygen" and "hydrogen."

Lavoisier had worked as a tax collector. This made him unpopular with the new government after the French Revolution. He was executed with a machine called a guillotine (GEE-yuh-teen) in 1794.

GETTING TO KNOW: Antoine-Laurent Lavoisier

Releasing Energy

The temperature of chemicals changes as they react with each other. Heat is either released or absorbed during a chemical reaction. The compound becomes warm or hot when heat is released. This is called an exothermic (eck-so-THUR-mick) reaction. Most of the chemical reactions that occur in nature are slow exothermic reactions. They take place so slowly that it is difficult to notice the release of heat. Exothermic reactions are often easy to see when fuels are burned. Energy is released from oxidation that occurs while fuel is burning. This is why fires are so hot.

Exothermic Reactions

Endothermic Reaction

The reacting chemicals become cooler when heat is absorbed. This is called an endothermic (en-duh-THUR-mick) reaction. Photosynthesis is one of the few natural

endothermic reactions. Plants actually get a little bit cooler as they convert sunlight, carbon dioxide, and water into oxygen and food. Cold packs are used by doctors and athletes to lower the temperature of an injury. A cold pack contains two chemicals that react with each other when they are mixed. The endothermic reaction absorbs heat from the injured part of the body.

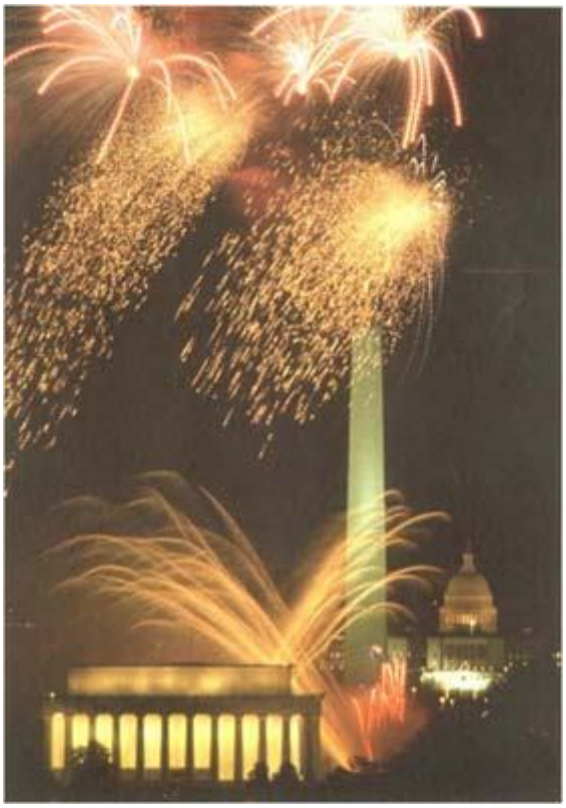
Explosions

A chemical reaction might blow up, or explode, when it releases a lot of energy all at once. Explosions (ik-SPLO-zhunz) are very fast exothermic reactions. These reactions can happen in many different ways.

Explosions on the Earth often take place when there are combustible (kum-BUS-tuh-bul) materials around. These are materials that bond easily with oxygen. This reaction is sometimes called explosive oxidation. Gases like hydrogen, methane, butane, and propane all can explode if they mix with oxygen and come in contact with a flame. Some liquids can explode if they become a gas called vapor (VAY-pur). Vapors allow molecules to bond with oxygen much more easily. Gasoline can explode if a spark ignites gasoline fumes.

Explosions

Other explosions do not need oxygen from the air. Explosive materials often contain chemicals that provide their own oxygen. Gunpowder is a mixture of potassium nitrate, sulfur, and carbon. Potassium nitrate (KNO[SUB3]) contains lots of oxygen for sulfur and carbon to react with. Gunpowder burns by getting its oxygen from potassium nitrate, not the air. Dynamite is an explosive made from tightly packed gunpowder. When dynamite is ignited, it makes a very powerful explosion. Fireworks use various amounts of gunpowder and other chemicals. These mixtures make the variety of colors and explosions seen in fireworks displays.



Fireworks

GETTING TO KNOW...

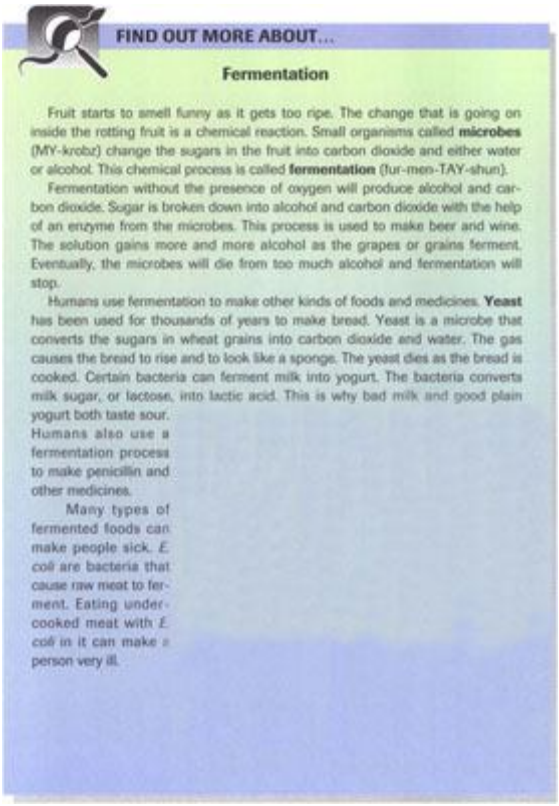
Joseph Black

Joseph Black was born in 1728 in France, where his father sold wine. His father was from Ireland and sent Black there for his education. Black went to college in Scotland and lived there the rest of his life.

Black performed experiments with the compound magnesium carbonate ($MgCO^3$). He heated it and made magnesium oxide. Then he added potassium carbonate and made $MgCO^3$ again. Black realized these reactions were taking away and adding a gas that he called "fixed air." Today, it is called carbon dioxide.

Black is known for his study of heat. He showed that different substances need more or less heating time to reach the same temperature. He also noticed that phase changes can gain or lose heat.

GETTING TO KNOW: Joseph Black



FIND OUT MORE ABOUT...

Fermentation

Fruit starts to smell funny as it gets too ripe. The change that is going on inside the rotting fruit is a chemical reaction. Small organisms called **microbes** (MY-krobz) change the sugars in the fruit into carbon dioxide and either water or alcohol. This chemical process is called **fermentation** (fur-men-TAY-shun).

Fermentation without the presence of oxygen will produce alcohol and carbon dioxide. Sugar is broken down into alcohol and carbon dioxide with the help of an enzyme from the microbes. This process is used to make beer and wine. The solution gains more and more alcohol as the grapes or grains ferment. Eventually, the microbes will die from too much alcohol and fermentation will stop.

Humans use fermentation to make other kinds of foods and medicines. **Yeast** has been used for thousands of years to make bread. Yeast is a microbe that converts the sugars in wheat grains into carbon dioxide and water. The gas causes the bread to rise and to look like a sponge. The yeast dies as the bread is cooked. Certain bacteria can ferment milk into yogurt. The bacteria converts milk sugar, or lactose, into lactic acid. This is why bad milk and good plain yogurt both taste sour. Humans also use a fermentation process to make penicillin and other medicines.

Many types of fermented foods can make people sick. *E. coli* are bacteria that cause raw meat to ferment. Eating undercooked meat with *E. coli* in it can make a person very ill.

FIND OUT MORE ABOUT: Fermentation

Penicillin

People Who Study Chemistry

Hundreds of years ago, people called alchemists (AL-kuh-mists) used chemical reactions to make medicines and combine metals. Some of them thought they could create gold from other metals or make people live forever. Unfortunately, they were wrong. Today, a lot more is known about how things really work.

Chemistry is the study of how chemicals react with one another and the products that they make. Chemists are people who study chemistry. There are many different kinds of

chemists. Analytic (ah-nul-IH-tick) chemists use computers to study chemical reactions. Organic chemists study molecules and compounds that contain carbon. These compounds include everything from fuels like gasoline to foods like candy. Physical chemists study reactions and conduct many experiments. Nuclear (NEW-klee-ur) chemists study the atom and its parts.

Other fields in science use chemistry. Medical doctors study biochemistry and pharmacology (far-muhKAW-luh-jee). Biochemists study the chemistry of living things like the human body. Pharmacists (FAR-muh-sists) use their knowledge of chemistry to make drugs and medicines. Special effects in the movies often require a knowledge of chemistry. Pyrotechnicians (pi-ruh-teck-NIH-shunz) make things explode for special effects and fireworks displays.

Pharmacology

Pharmacists

Chemistry makes life possible. Everything from the tiniest atoms to the blood in our bodies to the shoes on our feet is the result of chemical reactions. People will keep learning about chemistry and how it affects our lives.

Chemistry makes life possible

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By Jason Georges and Tracy Irons-Georges
