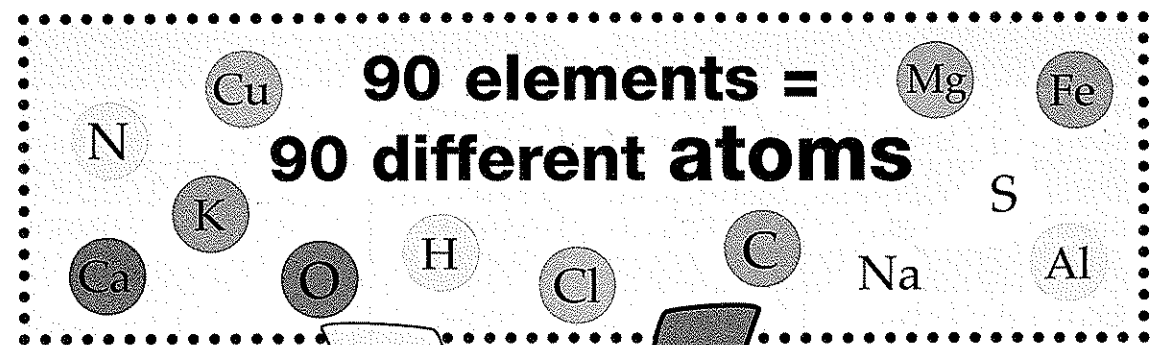


# ATOMS AND COMPOUNDS



Atoms combine to make new substances

1 kind of atom = elements



2+ kinds of atoms = compounds



Strong bonds between atoms = molecules



Weak bonds between atoms = ionic compounds



# White Substances Information

## Ascorbic Acid

Ascorbic acid ( $C_6H_8O_6$ ), better known as vitamin C, is essential in the human diet. All vertebrates (animals with backbones), except primates (including humans) and guinea pigs, make their own vitamin C. Guinea pigs and primates must get it from foods, like citrus fruit, tomatoes, and liver.

Vitamin C helps body tissues grow and heal. It helps make an important protein called collagen, which is found in bones, cartilage, soft tissues, and teeth. Without vitamin C, joints hurt and grow weak, gums bleed, and teeth loosen, making it very difficult and painful to eat. The final result is death. Pretty severe consequences for not eating enough vitamin C!

The connection between these symptoms, called scurvy, and vitamin C was unknown until the late 1700s. A British naval doctor, James Lind (1716–1794), observed that eating citrus fruits cured scurvy. From that time on, sailors were required to drink lime or lemon juice to prevent scurvy.

You may have heard that a massive dose of vitamin C can prevent the common cold. According to medical studies, however, this isn't true. There are definite health benefits associated with vitamin C, but cold prevention is not one of them.

## Calcium Carbonate

Calcium carbonate ( $CaCO_3$ ) is a common mineral found in sedimentary rock, such as chalk, limestone, and marble. Carbonate rocks account for about 4% of the mass of Earth's crust. Calcium carbonate is also important in ocean ecosystems. Snails, oysters, and clams make their shells out of it. And when you see a coral reef, you are looking at the calcium carbonate skeletons of millions of tiny animals called corals.

Calcium carbonate is an inexpensive source of calcium used in the calcium pills that people take to strengthen bones. It is also used in antacids to relieve acid indigestion after a big meal. Calcium carbonate neutralizes excess hydrochloric acid found in our stomachs.

And don't forget the chalkboard. Chalk is used in classrooms around the world. Writing chalk is usually made of calcium carbonate.

## Calcium Chloride

Calcium chloride ( $\text{CaCl}_2$ ) is a salt, but not the same salt you use to flavor foods. Calcium chloride has two useful properties. When it dissolves, it releases heat. This makes calcium chloride particularly good for melting ice on roads and sidewalks. And as the salt dissolves in the melted ice, it lowers the freezing point of water so it will not freeze again. Calcium chloride has another side benefit as road salt. It does not damage plants growing at the sides of roads nearly as much as other salts.

Calcium chloride is also hygroscopic. That means it absorbs water. Because it soaks up water so efficiently, it is used to dry air and other gases. It is also spread on dirt roads. The calcium chloride absorbs water, which holds down the dust.

Calcium chloride is added to concrete to make it set up faster and cure harder. It is used as a food additive (pickles particularly) to add a salty taste without increasing the sodium content of the food. This is important for people who are on low-sodium diets and cannot eat regular salt, which is sodium chloride.

## Citric Acid

Citric acid ( $\text{C}_6\text{H}_8\text{O}_7$ ) is found naturally in almost all plants and in many animal tissues and fluids. It is important in animal metabolism. You usually think of citric acid when you think of citrus fruits like lemons, oranges, tangerines, or grapefruits. But citric acid is also found in strawberries, apples, peaches, and even brown rice, soybeans, and wheat.

Most of the citric acid used in the United States finds its way into food. It is used to preserve foods, like jams and jellies. It is also used to give texture to processed cheese. Because citric acid, like all acids, has a sharp, sour taste, it is added to candies and soft drinks to give them a sour zing. Because of its taste, citric acid is sometimes referred to as "sour salt." When you pop a sour candy in your mouth and feel your cheeks pucker and get that momentary ache in your jaw, you are having a citric acid moment.

## Magnesium Sulfate

Ahhh, soak those sore feet in a nice warm bath of Epsom salts. People have soothed their sore feet in naturally occurring magnesium sulfate ( $\text{MgSO}_4$ ) mineral springs for centuries.

Perhaps the most famous magnesium sulfate spring is located in Epsom, England. Hence the name Epsom salts. In the early 1600s, a farmer noticed that his thirsty cattle would not drink at a certain spring. He tasted the water. It was very bitter and unsuitable for drinking. But the magnesium sulfate salts were found to be relaxing and medicinal. This discovery led to the creation of the famous Epsom Spa and the first patent for medicine in England in 1698.

Today magnesium sulfate is sold in drugstores as a soaking agent for bruised, tired feet. It is also an effective laxative, providing relief from constipation. It is not too difficult to find other places where magnesium sulfate is used. It is found in fertilizers as a source of magnesium, in detergents and soaps, and in stainless steel flatware as a filler in hollow handles. It is even added to purified water to give it some taste.

## Sodium Bicarbonate

Did you ever see a model volcano erupt? The "lava" was probably produced by mixing sodium bicarbonate ( $\text{NaHCO}_3$ ) and vinegar. Sodium bicarbonate's common name is baking soda. It is added to baked goods like biscuits to make them light and fluffy. When sodium bicarbonate reacts with acid, carbon dioxide gas forms. That gas makes the foam in the model volcano and causes the biscuit dough to rise.

Sodium bicarbonate is an ingredient in many brands of toothpaste. Why is it helpful? The bacteria that grow in your mouth give off acid as a waste product. That acid eats away at the outer layer of your teeth and causes them to decay. A toothpaste with sodium bicarbonate neutralizes the acid. In fact, sodium bicarbonate is so good at fighting tooth decay that some people use it alone to brush their teeth.

Sodium bicarbonate is also good for indigestion caused by excess stomach acid. That is why it is in many over-the-counter antacids. *Antacid* literally means "against acid." Sodium bicarbonate effectively neutralizes that extra acid, forming neutral products: carbon dioxide gas, table salt, and water.

## Sodium Carbonate

Sodium carbonate ( $\text{Na}_2\text{CO}_3$ ), known as washing soda or soda ash, is found naturally as trona ore in only a few parts of the world. The largest deposit of trona is in Wyoming.

Hundreds of years ago, soda ash was recovered from the ash from burned seaweed. In the 1700s, sodium carbonate, recovered from seaweed ashes, was used to make glass and soap.

Today a chemical process called the Solvay process can be used to make synthetic sodium carbonate. However, this process produces a number of hazardous wastes. The preferred method of obtaining sodium carbonate is still mining and refining it from natural ore.

Sodium carbonate is important in glassmaking. To make glass, you need to melt sand (silicon dioxide). Sand melts at  $1700^\circ\text{C}$ . But if you add sodium carbonate to the sand, it lowers the melting temperature, making it more cost effective to produce glass.

Glass production is the largest use for sodium carbonate, but sodium carbonate has many other uses. It is used in manufacturing detergents and soaps, making paper, and treating wastewater.

## Sodium Chloride

Sodium chloride ( $\text{NaCl}$ ), the salt you put on food, is so important that it has played a role in the development of civilization. Salt has led to war, has served as money, and is still considered a universal symbol of hospitality. Why is salt so important? Our bodies cannot make it but must have it. Without sodium and chlorine, our bodies cannot function properly.

Sodium is essential for muscle movement, heartbeat regulation, and nerve function. Chlorine is in stomach acid, making digestion possible. It also controls the movement of water into and out of cells.

Salt is an excellent preservative, used to keep meat, fish, and vegetables from spoiling. Food that has been salted and cured can remain edible for months. Pickling foods, like cucumbers (pickles), is another method of food preservation. Food is first soaked in brine (salt water), followed by vinegar. Before refrigerators, salt was the most important preservative.

Today sodium chloride is used for much more than preserving foods. The salt industry claims that salt has more than 14,000 uses! Most of the salt used in the United States goes to make other substances, like chlorine, sodium carbonate, and hydrochloric acid.

## Sucrose

Sucrose ( $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ ), best known as the refined white sugar used to sweeten foods, comes from plants. The two most important source plants are sugarcane and sugar beets.

About 70% of the sugar produced in the world is extracted from sugarcane, a very tall grass that looks like bamboo. It is grown in tropical regions around the world. The rest comes from sugar beets. Sugar beets are grown in northern, cooler climates and are roots. They look like fat, white carrots.

So why is sugar so important? It tastes good and is a source of energy in the human diet. There are 16 food calories of energy in every teaspoon of sucrose. So, if you are like most Americans, you eat 45 pounds of sugar per year! That's nine 5-pound bags, or about 2 ounces of sugar per day. That means that you eat almost 200 food calories per day of pure sucrose. That may be a bit much, but your body breaks down the sucrose into glucose that cells use as their most important fuel source. Sugar, in moderation, is an important part of our diet.

Sugar also has other uses. It is used in large quantities as a preservative in jams and jellies and is a food source for yeast in the making of bread.