

## Introduction

Did you ever wonder what is in air? Have you ever thought about how there are an incredible number of different things in the world? All that you see, touch, and feel is made from tiny units of matter. This unit will introduce you to these unseen building blocks of the universe.

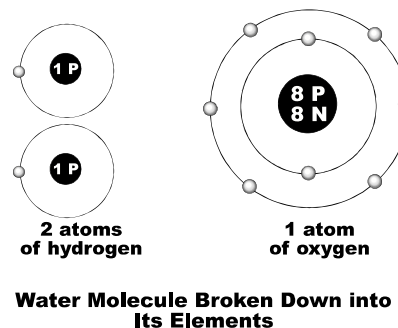
## Elements

There are thousands and thousands of different substances in the world. Water is a substance. Sugar is a substance. Oxygen is a substance. All of the substances that we know are made of **elements**. The elements are the substances that have unique chemical and physical properties. Elements cannot be broken down into other substances that are unique. Of water, sugar, oxygen, which is the element? One way to find out is through chemistry. If we break down the water, we will get hydrogen and oxygen gas. If we break down the sugar, we get hydrogen, oxygen, and carbon. We cannot use chemistry to break down the oxygen. This means that oxygen is the element. Oxygen is a part of such substances as water, sugar, carbon dioxide, rust, and wood.

## Atoms

All substances are made of **atoms**. Atoms are very tiny pieces of matter. An atom is the smallest unit of an element that is still that element. This may sound strange, but what it means is that an atom of gold is still gold. You cannot see that atom of gold. You cannot feel it. Despite this, it still has the physical and chemical properties of gold. Atoms still have all the properties of the element. An atom is the smallest unit of an element that can go through a chemical change. An atom can gain or lose **electrons**, a process which can then change its **charge**. Electrons are negatively charged particles that **orbit** the **nucleus** of an atom. If an atom gains extra electrons, it will become **negatively charged** (-). A loss of electrons will create a **positive charge** (+). There are about 120 different elements. So, there are about 120 different kinds of atoms. These atoms can combine with each other and form many different kinds of substances. One substance made from the combining of atoms is water. Water is made of two atoms of hydrogen and one atom of oxygen. One model for the

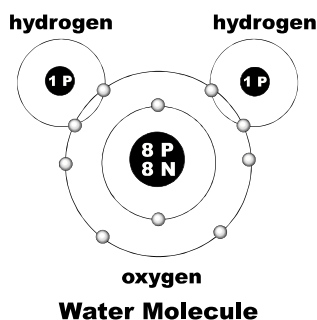
hydrogen atoms is shown here. Hydrogen has one **shell** of electrons. There is only one electron in the shell. The other, larger atom, is a similar model of oxygen. Oxygen has two shells of electrons. The outer shell has six electrons. In the next section we will talk about how these atoms combine. When two or more atoms combine, a chemical change takes place.



## Molecules

A **molecule** is formed when atoms share electrons. In chemical reactions, only electrons are involved. This is because only electrons are on the outside of the atoms. Because its electrons are shared, a molecule is always made of two or more atoms.

Look at the diagram of a water molecule on the left. It has two hydrogen atoms and one oxygen atom. Notice where the electrons are in the diagram of the water molecule. Each hydrogen atom has its own electron, but each now shares an electron with oxygen. Oxygen has six electrons in its outer shell. Oxygen now shares electrons with the hydrogen atoms. Because these three atoms are sharing electrons, they form a molecule. Water is the substance made of molecules that have two hydrogen atoms and one oxygen atom.



Some molecules are not made of different types of atoms. For instance, the element chlorine is often seen as a molecule. In this case, two atoms of chlorine share electrons. Even though chlorine is often a molecule, it is still an element. Why is this? If you broke the **bonds** between the water, you would have two gases (hydrogen and oxygen) which are very different from water. If you broke the bonds between chlorine atoms, you would still have chlorine. Chlorine is just one of the elements that commonly form molecules. In fact, both oxygen and hydrogen atoms will form molecules when not bonded to other atoms. Now that you know what a molecule is, the next section will discuss **compounds**.

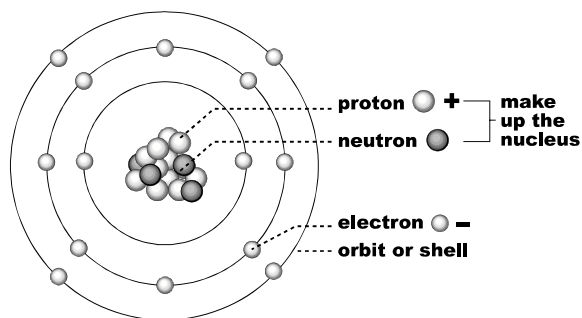
## Compounds

A compound has two or more atoms of different kinds. Oxygen, remember, is an element. Its molecules are made of two atoms of oxygen. Water, however, is a compound. Its molecules are made of two atoms of hydrogen and one atom of oxygen. The behavior of molecules is determined by the forces holding the molecules together. The molecules in matter help explain the differences between solids, liquids, and gases. In a solid, the molecules are very close together. They cannot move around very easily. The molecules in a liquid are further apart and can move easily. In a gas, the molecules are very far apart. They can move freely. That's why the molecules of a gas always can fill a container.

When matter changes phase, the distance between the molecules changes. Gaining heat usually causes the molecules to move apart. This may cause melting. Freezing, which is a loss of heat energy, causes the molecules to slow down and move closer together.

## Inside the Atom

It is hard to imagine anything as small as an atom, but atoms are made of even smaller parts. Except for hydrogen, atoms have **protons**, **neutrons**, and **electrons**. (Hydrogen is made only of a proton and an electron.) The middle part of an atom is called the nucleus. It is made of protons and neutrons. Around the nucleus are electrons. Electrons move around the center of the atom. The paths they follow are called orbits. Orbits group together at certain distances from the nucleus. Then the orbits are grouped together, and this is known as a shell.



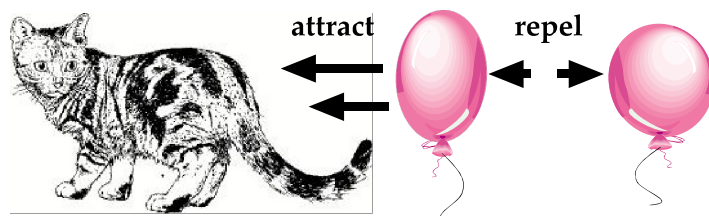
**Parts of the Atom**

Each part of the atom is important. The proton has a positive charge. In math or science, a positive is shown with a plus (+) sign. A neutron has no charge. (Neutron sounds almost like **neutral**.) The electron that orbits

around the center of the atom has a negative charge. Negative is shown by a minus (-) sign. The electrons are the part of the atom that react chemically with other atoms.

We said that a proton has a positive charge, a neutron has no charge, and an electron has a negative charge. What do we mean by the word “charge”? It stands for an electrical charge. Things that have the same charge push each other away or **repel**, but things that have different charges will move toward each other or **attract**. The forces that push and pull objects based on their charges are known as electrical forces. These electrical forces are often described by the phrase, “Opposites attract, likes repel.”

Usually matter is neutral. It has no charge. In an atom, the number of electrons (-) equals the number of protons (+). It is possible for an electron (-) to be added to an atom. Rub two balloons filled with air on a piece of fur or wood. The atoms in the balloons pick up an extra electron atom from the fur. They now have a negative (-) charge. Place the balloons next to each other. They will move away from each other. Remember, two negatives (-) will push away from or repel each other. What about the fur? It has lost electrons. Now it has a positive (+) charge. Rub a balloon on the fur. The balloon is negative (-) and the fur is positive (+). The balloon should move toward the fur.



*Opposites attract, likes repel.*

## Summary

We have learned some important facts about atoms. We know that they are the smallest unit of an element that is still the element. Elements are made of only one kind of atom. We know they form molecules when they share electrons. We also know they combine with other atoms to make compounds. Atoms have smaller parts called neutrons, protons, and electrons. We learned that same or like charges move away from each other. Different or unlike charges move toward each other.