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ATOMS AND MOTION

DISCOVERY OF THE **ATOM**

Democritus was a Greek philosopher, who lived about 2,500 years ago. He believed that when matter was broken up it would consist of tiny particles. He felt all things were made up of these small particles, which he called atoms. The word **atom** comes from the Greek word ATOMOS, which means "undivided." These tiny particles, or atoms, were too small to be seen with the naked eye, so it was difficult to prove that they existed. During the 18th century, scientific inquiry helped confirm that such things as atoms did indeed exist and that they were the basic units of all matter. Experiments at this time involved mostly the observation of matter in different situations and detailed record keeping.

In one such experiment, a liquid was observed under a microscope. Many small specks were seen suspended in the liquid moving around. It was thought that their movement was caused by the random movement of the atoms of the liquid. As the atoms of the liquid moved, they would hit these small specks and cause them to move as well. This was an indirect observation that suggested the existence of atoms.

During the next two centuries, experimental techniques became more sophisticated, and scientists were able to determine indirectly many characteristics of the **atom**. Scientists studied such things as its size, the nature of its behavior in different situations, and the amount of energy it supplied. Most advancements in atomic research have been made during the last 100 years.

EVERYTHING IS COMPOSED OF ATOMS

All matter is made up of atoms. There are four states of matter: solid, liquid, gas and plasma. We are surrounded by all forms of matter even though we cannot see them all. The air is made up of different gases. The Earth's oceans and lakes are filled with water (a liquid). Solids, such as wood, rock, steel and concrete, are everywhere. Plasma is found in the interior of stars and in fusion reactors.

The four states of matter have different characteristics. Solids have a definite shape, weight and volume. Liquids have a definite volume, but not a definite shape. Rather, they take on the shape of the container that holds them. Gases have no definite shape or volume. Plasma is a state of matter that occurs only at very high temperatures that pull the **atom** apart. Plasma is made up of just parts of the **atom** and has no definite shape or volume.

ENERGY OF ATOMS

The English word energy comes from the Greek word ENERGIA, which is defined as action. Motion is

associated with all forms of energy.

Atoms are always moving. Even in solid matter, the electrons of an **atom** still spin around the nucleus at great speeds. Solids, liquids, gases and plasma differ according to the energy level of their atoms. The atoms in gases are very energetic. They move about rapidly, seemingly at random. Atoms in liquid matter are somewhat more organized. They try to group themselves, but they still move about quite a bit and remain spaced apart. In solid matter, atoms show the least amount of energy. They are quite well organized and close together. The energy of these atoms is often not released until energy is supplied from an outside source.

As the activity of atoms increases, the amount of energy present increases. When matter changes form--as when water is heated to produce steam--energy is always used and released.

In the fourth state of matter, plasma, atoms no longer exist in their usual structure due to the intense heat. The **atom** has been pulled apart into electrons and a nucleus. The amount of activity and energy here is enormous.

INSIDE THE **ATOM**

An **atom** is far smaller than a strand of hair. It would require 300,000 atoms lined up side by side to equal the thickness of a single strand of hair. Every human being is made up of more atoms than there are grains of sand on the beach or stars in the universe.

For many years, scientists used a miniature solar system as a model for the structure of an **atom**. This model presented the Sun as the center with the planets orbiting around it. In the center of the **atom** is the nucleus. Ninety-nine percent of the **atom**'s mass is found here. The nucleus is made up of small particles called protons and neutrons. The proton has a positive charge, while the neutron is neutral, having no charge. They both have about the same mass or weight.

Electrons, from one to dozens of them, are in orbit around the nucleus. Electrons are very small particles compared to protons, and they have a negative charge. In general, each **atom** of a particular element contains the same number of protons and electrons. The number of neutrons varies with the weight and stability of the element. It is the difference in the total number of protons, neutrons and electrons of an **atom** that distinguishes the different elements.

By 1963, scientists had identified even smaller particles within the **atom**. The proton and neutron are made up of tiny particles called quarks, and the electron is made up of tiny particles called leptons. Today, these are considered the fundamental building blocks of nature. The structure of an **atom** now appears to be significantly different from the model of the solar system.

SEEING ATOMS

It wasn't until the 1950s that individual atoms were actually seen. They were viewed through a microscope called a field ion emission microscope, developed by E. Mueller. The first photographs of the **atom** were taken at this time as well.

The world's most powerful microscope was designed by University of Chicago physicist Albert Crewe in 1964. Since then, the design of the microscope has been continuously improved. The newest version will enable scientists to see particles as small as two-billionths of an inch in diameter. For the first time scientists will be able to see between atoms and evaluate the atomic structure and behavior of different substances.

MOLECULES

As atoms group themselves, they combine to form larger units called molecules. Molecules are held together by the electrons in orbit around the nuclei of the atoms. There are thousands of ways that atoms of different elements can join together to make new substances. These substances are called compounds. When different atoms combine to form molecules or when they split apart, some energy is lost and released in the form of heat.

FUNDAMENTAL FORCES OF NATURE

In nature, there are four known fundamental forces at work: gravity, electromagnetism, a strong nuclear force and a weak nuclear force. The gravitational force is the natural attraction that takes place between two particles. The electromagnetic force takes place between two particles that are electrically charged. The strong nuclear force is the force that holds particles together within the nucleus of an **atom**. The weak nuclear force also takes place in the nucleus and causes decay or weakening. It is this process that is responsible for radioactive decay. All forces now known to exist in nature can be accounted for by one of these fundamental types.