The Electron Cloud Model

Throughout the ages, scientists have changed their ideas of what an atom looks like. They have continued to do more and more experiments and make more and more observations. As they uncover new and different information, they must change their ideas of the model of the atom to fit the newly discovered information.

The current model of the atom is called the Electron Cloud Model. In this model, the atom is made of three basic parts, protons, neutrons, and electrons. The protons are positively-charged particles, and the neutrons are particles that do not have an electrical charge. The protons and neutrons are contained within the nucleus of the atom where they continuously move about at random. These particles contain most of the mass of the atom.

Recent atomic research has turned up evidence that protons and neutrons, although very tiny parts of an atom, are not the smallest parts. These particles themselves are made up of even smaller particles called quarks. Scientists now believe that each proton and each neutron within the nucleus of an atom is made up of three quarks. Research is still going on in this area, and new information is being released as scientists verify the results of ongoing experiments.

The electrons of an atom are negatively charged particles that form a cloud surrounding the nucleus of an atom. These particles have almost no mass, but they take up most of the space of the atom. The Electron Cloud Model differs from previous models of the atom concerning the location and behavior of the electrons.

In the early 1900s, Joseph John Thomson proposed a model in which the electrons were embedded in a positively charged sphere. Later, Ernest Rutherford changed the model to include a nucleus surrounded by electrons. Niels Bohr further modified the model by stating that each electron traveled around the nucleus in a fixed orbit. More recently, scientists have found evidence to support yet another change in the model, resulting in the currently accepted Electron Cloud Model.

In the latest model, scientists rely on the principle that opposite electric charges attract. The protons contained within the nucleus have positive charges. The electrons that encircle the nucleus have negative charges. The positive and negative charges are opposite; therefore, they are attracted to one another. Scientists believe this attraction is what keeps the electrons circling around the nucleus.

Scientists have found that each electron has certain amount of energy. The energy of the electron resists, to some extent, the attraction of the nucleus. The amount of this energy within the electron determines how much the electron can resist the attraction of the nucleus, so it determines the location of the electron. Electrons with less energy are
less resistant to the nucleus, so they will be found closer to the nucleus. Those electrons that have greater amounts of energy are more resistant to the nucleus and will be found farther away. Electrons in the outermost shell of an atom are called valence electrons.

Scientists believe that electrons are arranged in shells around the nucleus of the atom. The distance of the shell from the nucleus is determined by the amount of energy contained within the electrons in each shell.

Each electron shell is labeled with a number or a letter. The electron shells are labelled K, L, M, N, O, P, and Q; or 1, 2, 3, 4, 5, 6, and 7; going from innermost shell outwards. Electrons in outer shells have higher average energy and travel further from the nucleus than those in inner shells, making them more important in determining how the atom reacts chemically and behaves as a conductor, etc, because the pull of the atom's nucleus upon them is weaker and more easily broken.

Each electron shell can only hold a certain number of electrons. Each shell is composed of one or more subshells, which are themselves composed of atomic orbitals. For example, the first (K) shell has one subshell, called "1s"; the second (L) shell has two subshells, called "2s" and "2p"; the third shell has "3s", "3p", and "3d"; and so on.

- Each s subshell holds no more than two electrons
- Each p subshell holds no more than six electrons
- Each d subshell holds no more than ten electrons
- Each f subshell holds no more than fourteen electrons

Therefore, the K shell, which contains only an s subshell, can hold up to 2 electrons; the L shell, which contains an s and a p, can hold up to 2+6=8 electrons; and so forth. The maximum electrons in a shell can be calculated by $2n^2$ where $n$ stands for the number of shell.

Electrons travel freely within their shells. At any one time, it would be almost impossible to determine the exact location of a given electron. The best scientists can do at the present time is to determine which shells the electrons are in and how many electrons are in each shell.

People continue to be fascinated by chemistry and by the atom. Scientists continue to explore new ideas and to try new experiments. Sometimes their results confirm what other scientists have already learned. Sometimes their results pose new questions. As time goes on and scientists continue to try to satisfy their curiosity, the currently accepted model of an atom may be changed. Someday your children or grandchildren may try to explain a new model to you. If we can all continue trying to understand atoms and their behavior, we should be able to develop a greater understanding of the marvelous world around us.