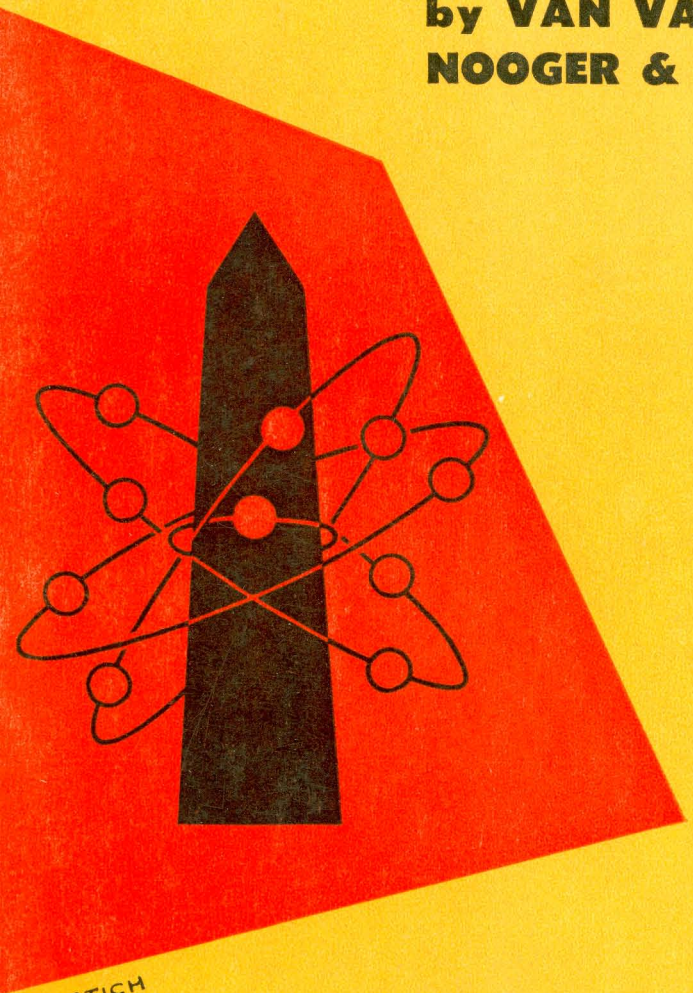
No. 169-1

basic electricity

by VAN VALKENBURGH, NOOGER & NEVILLE, INC.



VOL. 1

WHERE ELECTRICITY COMES FROM

ELECTRICITY IN ACTION

CURRENT FLOW, VOLTAGE, RESISTANCE

MAGNETISM, DC METERS

A. STICH

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$2.25

basic electricity

by VAN VALKENBURGH, NOOGER & NEVILLE, INC.

VOL. 1

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PREFACE

The texts of the entire Basic Electricity and Basic Electronics courses, as currently taught at Navy specialty schools, have now been released by the Navy for civilian use. This educational program has been an unqualified success. Since April, 1953, when it was first installed, over 25,000 Navy trainees have benefited by this instruction and the results have been outstanding.

The unique simplification of an ordinarily complex subject, the exceptional clarity of illustrations and text, and the plan of presenting one basic concept at a time, without involving complicated mathematics, all combine in making this course a better and quicker way to teach and learn basic electricity and electronics. The Basic Electronics portion of this course will be available as a separate series of volumes.

In releasing this material to the general public, the Navy hopes to provide the means for creating a nation-wide pool of pre-trained technicians, upon whom the Armed Forces could call in time of national emergency, without the need for precious weeks and months of schooling.

Perhaps of greater importance is the Navy's hope that through the release of this course, a direct contribution will be made toward increasing the technical knowledge of men and women throughout the country, as a step in making and keeping America strong.

Van Valkenburgh, Nooger and Neville, Inc.

New York, N. Y.
October, 1954

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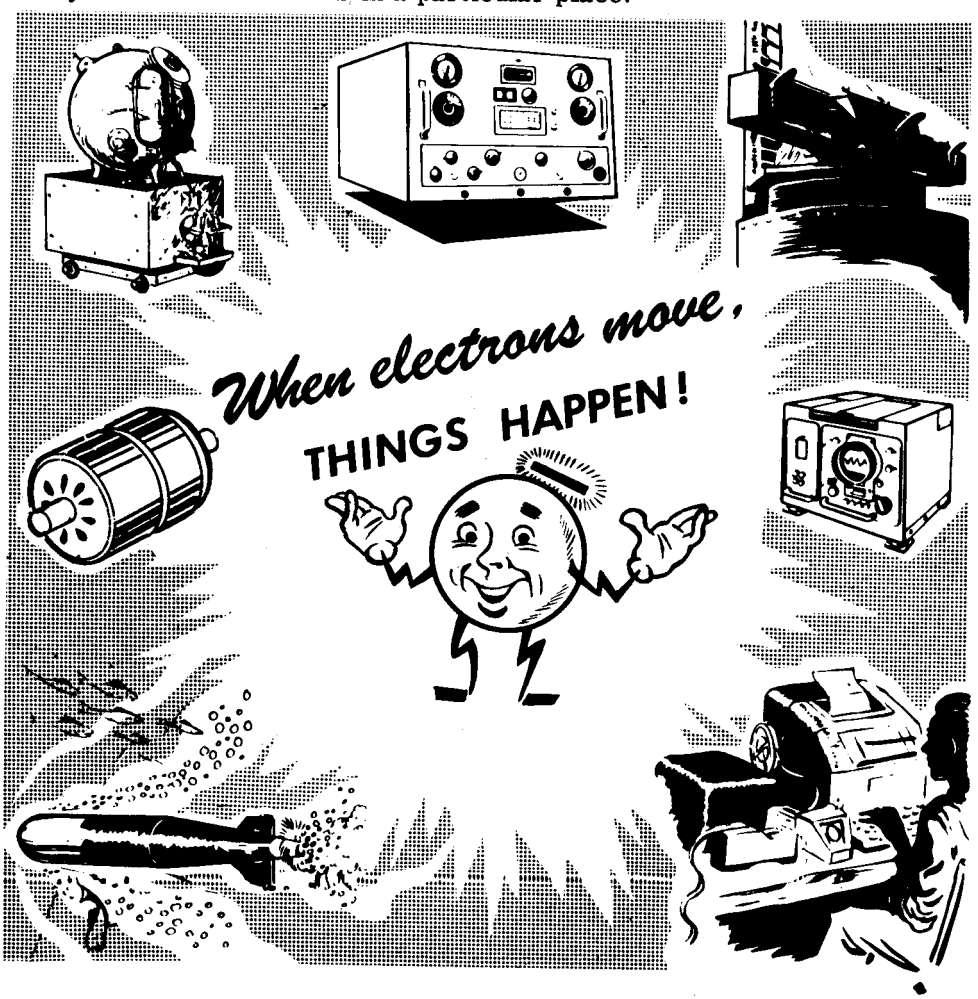
The Electron Theory

All the effects of electricity can be explained and predicted by assuming the existence of a tiny particle called the "electron." Using this "electron theory," scientists have been able to make predictions and discoveries which seemed impossible only a few years ago. The electron theory not only is the basis of design for all electrical and electronic equipment, it explains chemical action and allows chemists to predict and make new chemicals, such as the synthetic "wonder drugs."

Since assuming that the electron exists has led to so many important discoveries in electricity, electronics, chemistry and atomic physics, we can safely assume that the electron really exists. All electrical and electronic equipment has been designed using the electron theory. Since the electron theory has always worked for everyone, it will always work for you.

Your entire study of electricity will be based upon the electron theory. The electron theory assumes that all electrical and electronic effects are due to the movement of electrons from place to place or that there are too many or too few electrons in a particular place.

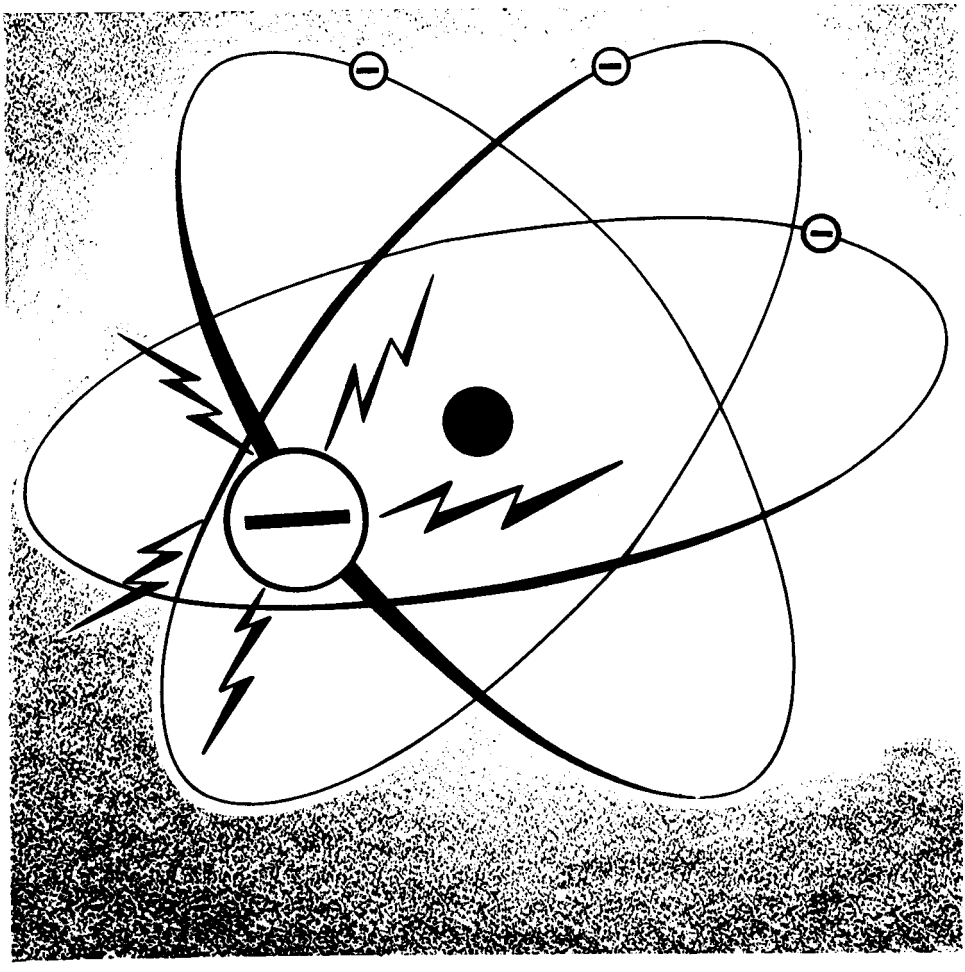


The Electron Theory (continued)

You have heard that electricity is the action of electrons in moving from point to point, or the excess or lack of electrons in a material. Before working with electricity, you will want to know exactly what an electron is and what causes it to move in a material. In order for electrons to move, some form of energy must be converted into electricity. Six forms of energy can be used and each may be considered to be a separate source of electricity.

However, before studying the kinds of energy which can cause an electron to move, you first must find out what an electron is. Because the electron is one part of an atom, you will need to know something about the atomic structure of matter.

THE ELECTRON IS ELECTRICITY



The Breakdown of Matter

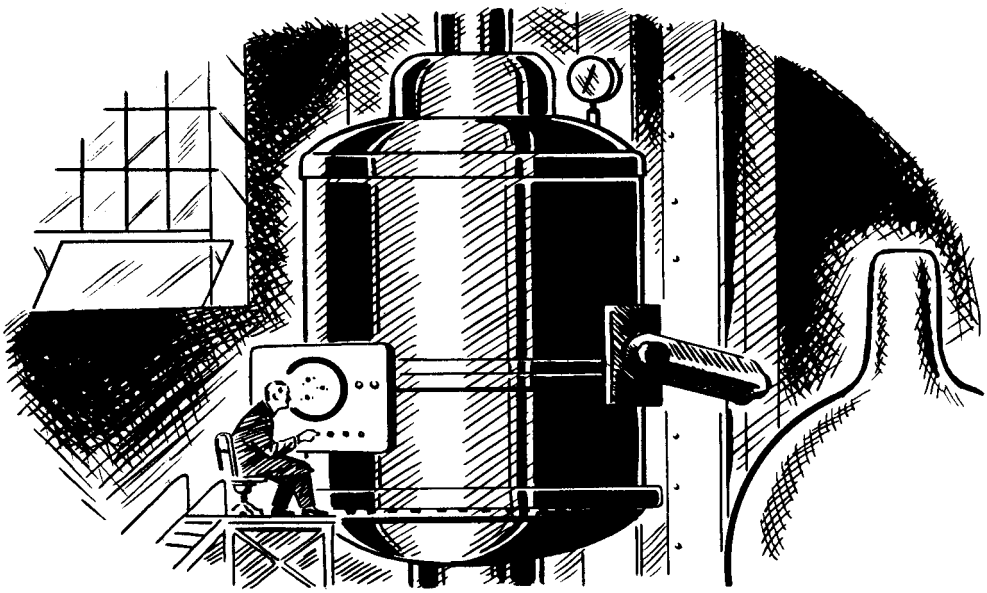
You have heard that electrons are tiny particles of electricity, but you may not have a very clear idea of the part electrons play in making up all the materials around us. You can find out about the electron by carefully examining the composition of any ordinary material—say a drop of water.

If you take this drop of water and divide it into two drops, divide one of these two drops into two smaller drops and repeat this process a few thousand times, you will have a very tiny drop of water. This tiny drop will be so small that you will need the best microscope made today in order to see it.

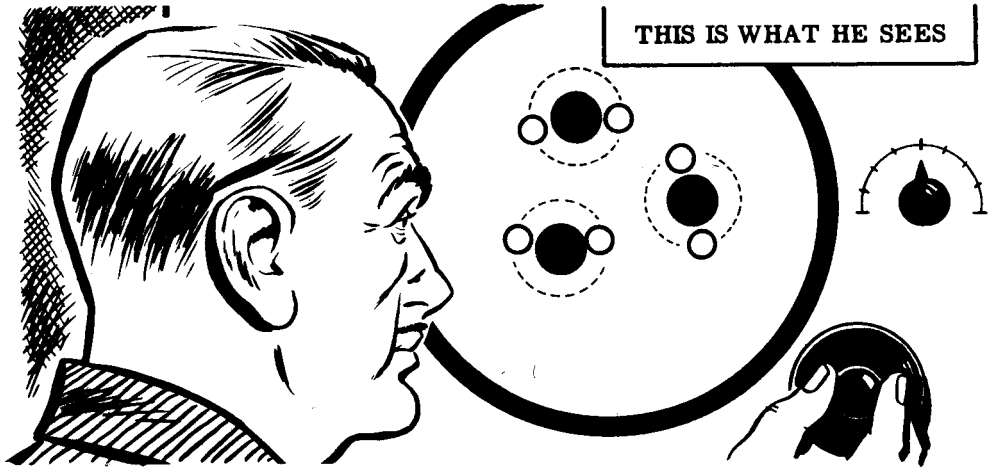
This tiny drop of water will still have all the chemical characteristics of water. It can be examined by a chemist, and he will not be able to find any chemical difference between this microscopic drop and an ordinary glass of water.

The Breakdown of Matter (continued)

Now if you take this tiny drop of water and try to divide it in half any further, you will not be able to see it in your microscope. Imagine that you have available a super microscope which will magnify many times as much as any microscope presently existing. This microscope can give you any magnification you want, so you can put your tiny drop of water under it and proceed to divide it into smaller and smaller droplets.

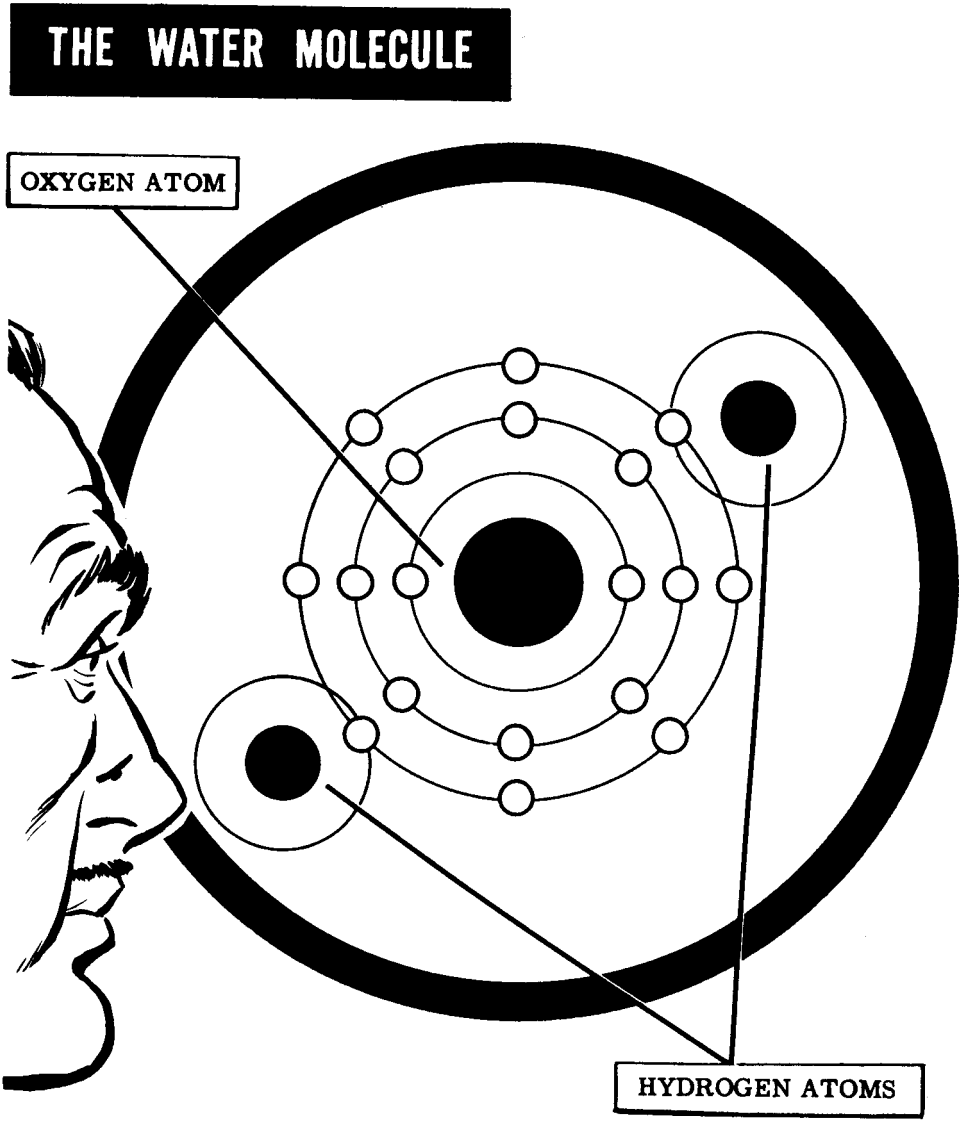


As the droplet of water is divided into smaller and smaller droplets, these tiny droplets will still have all the chemical characteristics of water. However, you eventually will have a droplet so small that any further division will cause it to lose the chemical characteristics of water. This last bit of water is called a "molecule." If you examine the water molecule under high magnification, you will see that it is composed of three parts closely bonded together.



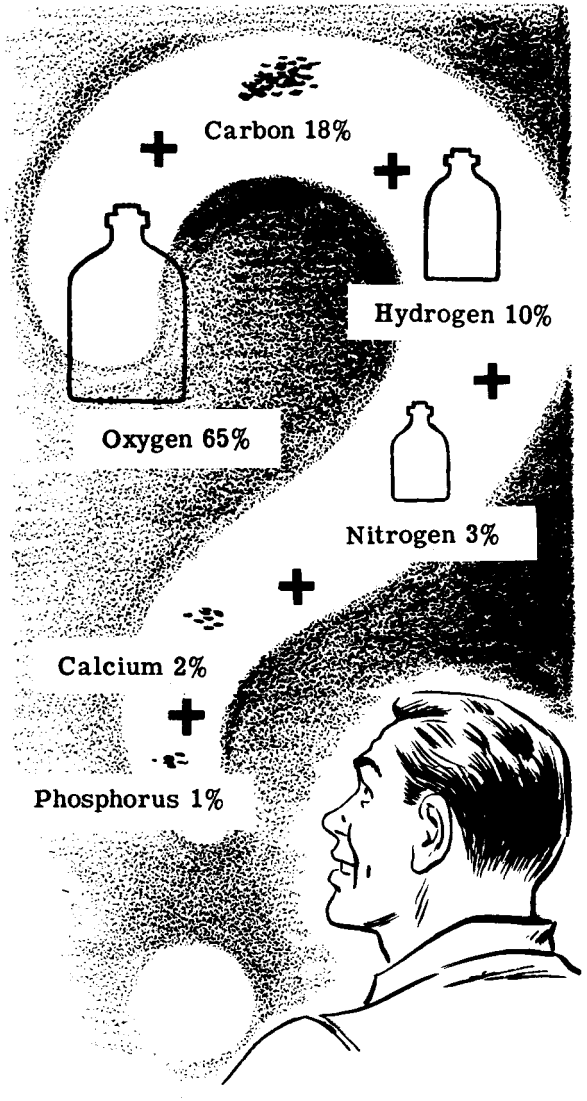
The Structure of the Molecule

When you increase the magnifying power of the microscope, you will see that the water molecule is made up of two tiny structures that are the same and a larger structure that is different from the two. These tiny structures are called "atoms." The two tiny atoms which are the same are hydrogen atoms and the larger different one is an oxygen atom. When two atoms of hydrogen combine with one atom of oxygen, you have a molecule of water.



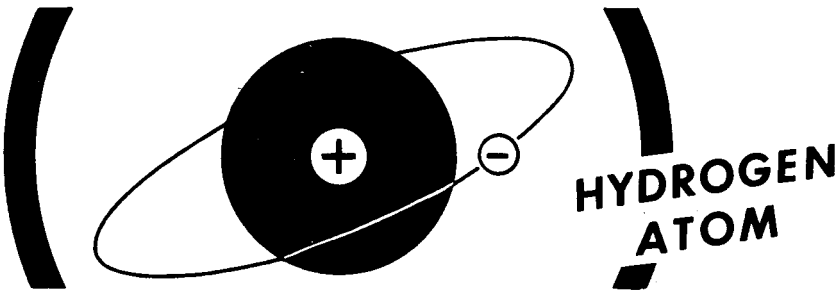
The Structure of the Molecule (continued)

While water is made up of only two kinds of atoms—oxygen and hydrogen —the molecules of many materials are more complex in structure. Cellulose molecules, the basic molecules of which wood is made, consist of three different kinds of atoms—carbon, hydrogen and oxygen. All materials are made up of different combinations of atoms to form molecules of the materials. There are only about 100 different kinds of atoms and these are known as elements: oxygen, carbon, hydrogen, iron, gold, nitrogen are all elements. The human body with all its complex tissues, bones, teeth, etc. is made up of only 15 elements, and only six of these are found in reasonable quantities.



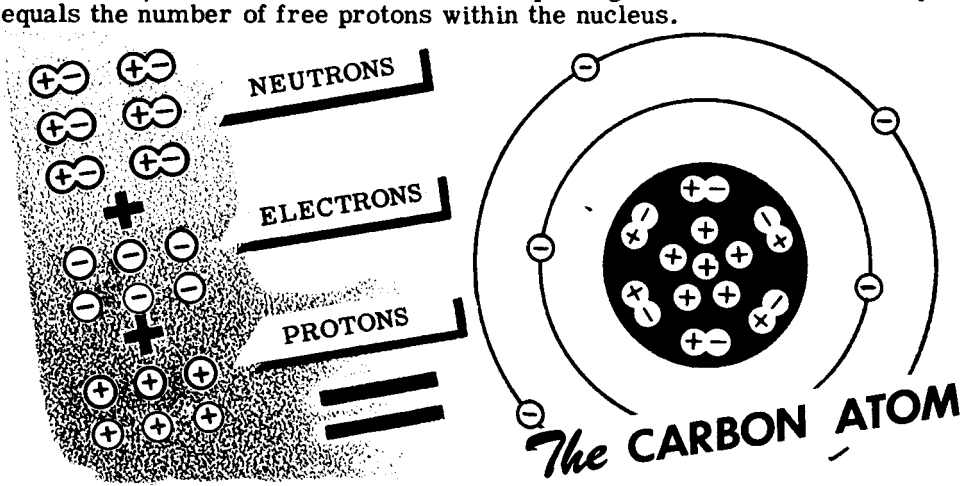
The Breakdown of the Atom

Now that you know that all materials are made up of molecules which consist of various combinations of about only 100 different types of atoms, you will want to know what all this has to do with electricity. Increase the magnification of your imaginery super microscope still further and examine one of the atoms you find in the water molecule. Pick out the smallest atom you can see—the hydrogen atom—and examine it closely.



You see that the hydrogen atom is like a sun with one planet spinning around it. The planet is known as an "electron" and the sun is known as the "nucleus." The electron has a negative charge of electricity and the nucleus has a positive charge of electricity.

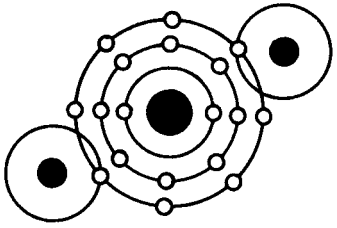
In an atom, the total number of negatively-charged electrons circling around the nucleus exactly equals the number of extra positive charges in the nucleus. The positive charges are called "protons." Besides the protons, the nucleus also contains electrically neutral particles called "neutrons," which are made up of a proton and an electron bonded together. Atoms of different elements contain different numbers of neutrons within the nucleus, but the number of electrons spinning about the nucleus always equals the number of free protons within the nucleus.



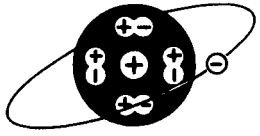
Electrons in the outer orbits of an atom are attracted to the nucleus by less force than electrons whose orbits are near the nucleus. These outer electrons are called "free" electrons and may be easily forced from their orbits, while electrons in the inner orbits are called "bound" electrons since they cannot be forced out of their orbits easily. It is the motion of the free electrons that makes up an electric current.

Review of Electricity—What It Is

Now let's stop and review what you have found out about electricity and the electron theory. Then you will be ready to study where electricity comes from.

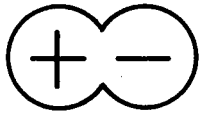


1. MOLECULE—The combination of two or more atoms.

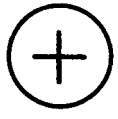


2. ATOM—The smallest physical particle into which an element can be divided.

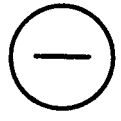
3. NUCLEUS—The heavy positively-charged part of the atom which does not move.



4. NEUTRON—The heavy neutral particle in the nucleus consisting of a proton and an electron.



5. PROTON—The heavy positively-charged particle in the nucleus.



6. ELECTRON—The very small negatively-charged particle which is practically weightless and circles the nucleus.

7. BOUND ELECTRONS—Electrons in the inner orbits of an atom, which cannot easily be forced out of their orbits.

8. FREE ELECTRONS—Electrons in the outer orbits of an atom, which can easily be forced out of their orbits.

9. ELECTRICITY—The effect of electrons in moving from point to point, or the effect of too many (excess) or too few (lack of) electrons in a material.