Electronics

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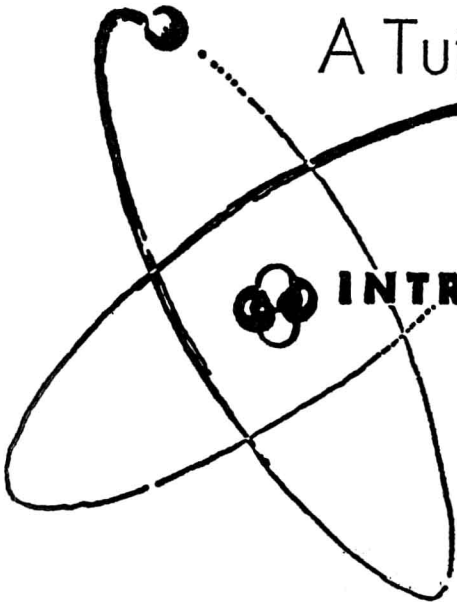
INTRODUCTION TO ELECTRONICS



A TutorText* Book

INTRODUCTION TO

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INTRODUCTION

Electronics is a science of vast scope, tremendous power, and seemingly unlimited possibilities. It deals with the control and use of atomic particles called "electrons."

By controlling electrons, we can transmit sound and moving pictures through space, sense the presence of unseen objects, peer at molecules, smash atoms, explore the stars, and fight cancer.

Electronics is destined to play an increasingly important role in the lives of all of us. Probably no job being done by men today will remain totally unaffected by future advances in electronics. Up to now, the greatest impact of electronics has been in entertainment and communications. Radio, television, and recordings have revolutionized leisure-time activities. Industry in general is beginning to harness the power of electronics for control, inspection, computing, and production. Anyone acquainted with what electronics can do will predict advances in many new directions, in medicine, agriculture, stores, offices, and the home.

This book is for the person who wants to gain an understanding of electronics, either as a prelude to advanced study or as a matter of intelligent interest. The principles set forth here in terms of radio communication are valid in every application of electronics. There are only a half-dozen devices to control electron activity in common use. The whole wonderful world of electronics is made up of such simple devices as the resistor, the capacitor, the coil, the transistor, and the vacuum tube. When you understand how and why each of these things works, you'll be well on your way to understanding any circuit. And, if you're like most people who have started to study electronics, you'll find that the deeper you go, the more fascinating the whole business becomes.

You will find that it's impossible to skip through this book, picking up only a smattering of knowledge in a vast subject. Instead, this TutorText* is designed to teach you a great deal about the fundamentals of electronics. You will be questioned continuously on each point as you read, and only by answering each question can you proceed to the next point.

* Trademark

The automatic tutoring system used in this book was developed by Norman A. Crowder, a psychologist who is the technical director of the Educational Science Division of U. S. Industries, Inc., New York City. This book was written in the Training Systems Department, under the technical and editorial supervision of Mr. Crowder. The authors wish to express their appreciation for his guidance and invaluable assistance.

Special thanks are accorded Dr. Joseph J. Sayovitz, chairman of the Department of Industrial Arts of the University of California at Santa Barbara, for giving us the benefit of his long experience in teaching electronics and his deep knowledge of the subject.

NOTE TO THE READER

This is not an ordinary book. The pages are numbered in the usual way, but they are not read consecutively. You must follow the directions which you find at the bottom of each page.

You will find that reading this book is very much like having an individual tutor. The book will continually ask you questions and correct errors as well as give you information.

Your progress through this course will depend entirely on your ability to choose right answers instead of wrong ones—and by your endurance. It is not recommended, however, that you try to go through this course in one sitting, or even in two or three. The course is divided into lessons, and a number of short learning sessions produces better results than a few long ones.

Follow the instructions and you'll find it's impossible to get to the final page without mastering the fundamentals of electronics.

CONTENTS

LESSON 1

The Unit of Electricity

The study of electronics begins with atomic theory.

This may strike you as going at things the hard way. However, it's not. Mastering theory is the simplest way to learn a great deal about many different things in the least possible time with the least possible effort. Furthermore, only by understanding theory can we hope to predict new experience with reliability, and this is the goal of all learning.

So to begin at the beginning. . . .

There are about 100 different *elements* in the universe. Among the common or familiar elements are hydrogen, oxygen, silver, gold, carbon, copper, and iron.

All matter is made up of elements, either alone or in combination with each other.

Suppose you were to take a quantity of some element, such as carbon, and divide it into smaller and smaller portions. Eventually you would get down to an incredibly small unit of carbon which couldn't be divided any further without ceasing to be carbon. That would be the carbon *atom.*

So all matter is made up of atoms, and an atom is the smallest particle into which an element can be divided and still retain its identity as an element.

Each atom of a particular substance is like every other atom of that substance, but differs from atoms of all other substances.

Now here are two statements about the material you have just read. Pick the one you believe to be correct and turn to the page indicated.

An atom is the smallest particle of matter. **page 7**

An atom is not the smallest particle of matter. **page 10**

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You did not follow instructions.

This course in electronics is not put together like an ordinary book. You do not turn directly from page 1 to page 2 to page 3, and so on. This TutorText will make no sense if you try to follow that procedure.

Each page that you read will tell you what page to turn to next. Now there was no way you could have arrived at this page if you had followed instructions.

Please turn to page 1 and select the correct page to read next.

YOUR ANSWER: True.

You are correct. For most practical purposes, there's nothing in a lemon but whirling electrons, protons, and empty space. Or in anything else.

The only difference between atoms is in the *number* of neutrons, protons, and electrons they have. Hydrogen, the lightest of the elements, is composed of one proton, one electron, and no neutrons. Carbon is known to have six protons, six electrons, and six neutrons. Oxygen has eight protons, eight electrons, and eight neutrons. Elements such as lead, mercury, and uranium have more than two hundred protons and neutrons.

There is an important thing to remember about these three types of atomic particles. Every proton is just like every other proton. Every electron is just like every other electron. And every neutron is just like every other neutron. Every particle theoretically could be exchanged with any other particle of the same type. It is the same way with the bricks used to put together a house. You can build all kinds of different houses using the same kind of bricks. The difference in the houses depends on the number and arrangement of the bricks.

Another important thing to remember is that the size of atoms is almost beyond our imagination. Just for fun, try this question:

*A*_____*B*

This is a line one inch long. How many hydrogen atoms would it take to reach from Point *A* to Point *B*?

2500. **page 9**

250,000,000. **page 16**

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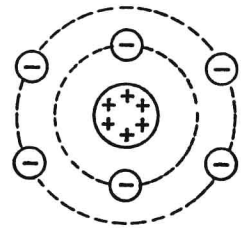
[*from page 16*]

YOUR ANSWER: The atom would be left with a negative electrical charge.

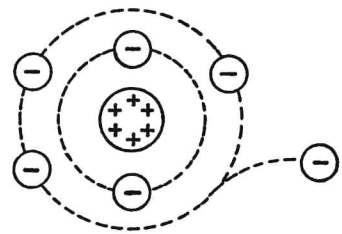
In our problem, we stated that an electron, which has a negative electrical charge, is rubbed away from an atom.

Here is a diagram of an atom with positive and negative charges neatly balanced. Six protons in the nucleus, six electrons in orbit. (This happens to be an atom of carbon.)



CARBON ATOM

Now remove one electron.



CARBON ATOMS
(with one electron removed)

You're left with six positive charges—but only five negative charges, aren't you? So the carbon atom is left with one extra positive charge. And a free electron, bearing one negative charge, goes off by itself somewhere.

When an atom loses an electron, the atom becomes *positively charged.*

Please return to page 16 and select the correct answer.

YOUR ANSWER: Free electrons are not attracted to a nucleus.

Sorry, but you've gone a little beyond the facts. If free electrons were not attracted to any nucleus, we'd have electrical charges and currents all over the place!

When an electron is way out in orbit, a long way from its own nucleus, it may be fairly close to the nucleus of a neighboring atom. The application of force may kick such an electron from one atom to another where it will enter a new orbit. The electrons that move from one atom to another may be called "free," and that's all there is to it. They're no different from any other electron, in mass, charge, or any other property.

Now return to page 11 and select the correct answer.

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[from page 15]

YOUR ANSWER: Electrostatic attraction is attraction between electrons.

No. You got things exactly backwards. Electrons don't attract each other, they repel each other. In fact it is true to say, "Like charges repel."

Thus, if the surface of your skin is negatively charged through having an excess of free electrons, electrons on each hair on your skin will get as far away as possible, right on the end of the hair, seeking a positively charged surface. This is why the hairs prickle and stand erect when charged.

Return to page 15 and pick the right answer.

YOUR ANSWER: An atom is the smallest particle of matter.

Sorry, but you missed an important qualification. An atom is the smallest particle into which an element can be divided *and still retain its identity as an element.*

We think we know quite a bit today about the composition of the atom. From our point of view, the most important component of the atom is the *electron,* which is very small compared to the rest of the atom.

Please return to page 1 and select the correct answer.