DOCUMENT RESUME

ED 198 336 CE 028 025

TITLE Exploring Careers. Scientific and Technical Occupations.
INSTITUTION Bureau of Labor Statistics (DOL), Washington, D.C.
REPORT NO BLS-Bull-2001-9
PUB DATE 79
NOTE 43p.; Photographs will not reproduce well. For related documents see CE 028 017-031.
AVAILABLE FROM Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Biochemistry; Biological Sciences; *Broadcast Industry; Career Awareness; Career Choice; *Career Exploration; Educational Needs; Education Work Relationship; Employment Qualifications; Engineers; Environmental Research; Junior High Schools; Learning Activities; Mathematicians; *Occupational Information; Physical Sciences; Resource Materials; *Science Careers; Scientists; Self Evaluation (Individuals); *Technical Occupations; Work Attitudes
IDENTIFIERS *Electrical Engineering

ABSTRACT

"Exploring Careers" is a career education resource program, published in fifteen separate booklets, for junior high school-age students. It provides information about the world of work and offers its readers a way of learning about themselves and relating that information to career choices. The publications aim to build career awareness by means of occupational narratives, evaluative questions, activities, and career games grouped in fourteen occupational clusters. This ninth of the series, "Scientific and Technical Occupations," presents an overview of jobs in science, such as engineers, technicians, and meteorologists. Narrative accounts focus on a biochemist, an electrical engineer, and a broadcast technician, describing what they do and how they prepared for their careers. Exploring sections relate skills needed for these occupations to students' personal characteristics, and learning activities such as inviting a chemist to speak to the class and becoming a ham radio operator are suggested. A Job Facts section lists nature and places of work, training and qualifications, and other information for twenty-eight scientific and technical occupations, grouped into occupational clusters of life science, physical science, environmental science, mathematics, engineering, and technician occupations. ("Exploring Careers also is available as a single volume of fifteen chapters.) (KC)

Exploring Careers

Scientific and Technical Occupations

U.S. Department of Labor
Ray Marshall, Secretary

Bureau of Labor Statistics
Janet L. Norwood, Commissioner
1979

Bulletin 2001-9

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402

Exploring Careers is available either as a single volume of 15 chapters or as separate chapters, as follows:

The World of Work and You
Industrial Production Occupations
Office Occupations
Service Occupations
Education Occupations
Sales Occupations
Construction Occupations
Transportation Occupations
Scientific and Technical Occupations
Mechanics and Repairers
Health Occupations
Social Scientists
Social Service Occupations
Performing Arts, Design, and Communications Occupations
Agriculture, Forestry, and Fishery Occupations

Photograph Credits

Photography for *Exploring Careers* was directed by Max L. Carey of the Bureau of Labor Statistics, Division of Occupational Outlook. Members of the Division's staff who assisted with obtaining and editing photographs were Anne Kahl, Kathy Wilson, Chester Curtis Levine, and Gloria D. Blue. Contributing photographers were Al Whitley of Whitley Associates, and Harrison E. Allen, Robert Donaldson, and Fleming P. Rose of the U.S. Department of Labor, Division of Graphic Services. The Bureau gratefully acknowledges the cooperation of the many government and private sources that either contributed photographs or made their facilities available to photographers. Depiction of company or trade names in no way constitutes endorsement by the Department of Labor. Some photographs may not be free of every possible safety or health hazard.

Government Sources

Federal. Armed Forces Radiobiology Institute; Board of Governors of the Federal Reserve System; Bureau of Prisons; Department of Agriculture; Department of Health, Education, and Welfare; Department of the Interior; Federal Aviation Administration; Government Printing Office; National Aeronautics and Space Administration; National Institute of Mental Health; National Park Service; Smithsonian Institution; Tennessee Valley Authority; and U.S. Postal Service.

State and local. City of San Antonio; City of San Diego; District of Columbia—Department of Human Resources, Police Department; Fairfax County (Va.)—Public Schools, Public Libraries; Maryland National Capital Park and Planning Commission; Montgomery County Public Schools (Md.); University of Texas Health Science Center at San Antonio; and Washington Metropolitan Area Transit Authority.

Private Sources

Individuals. Robert Devlin; Robert Miller; The Honorable Eligio de la Garza; The Honorable Henry B. Gonzalez; The Honorable Daniel K. Inouye; and David Weitzer.

Membership groups. Air Transportation Association of America; American Iron and Steel Institute; American Petroleum Institute; Associated General Contractors of America; Association of American Railroads; Chamber of Commerce of the U.S.A.; International Association of Machinists and Aerospace Workers; Motor Vehicle Manufacturers Association of the U.S., Inc.; National Education Association; and United Brotherhood of Carpenters and Joiners of America.

Industry and business. Allen-Mitchell and Co.; American Telephone and Telegraph Co.; Arlington Hobby Crafters; Babcock and Wilcox Co.; Badger America Inc.; The Big Cheese; Blake Construction Co.; Bob Peck Chevrolet; Carl T. Jones Associates; Chase Manhattan Bank; Chessie System; Cycles Inc.; Del Mercado Shell Service Center; Everhart Jewelers; General Truck Sales; The Hecht Co.; Hyatt Regency of Washington; Heritage Exxon Servicenter; International Business Machines Corp.; Mayflower Hotel; Merrill Lynch Pierce Fenner and Smith, Inc.; Navy Marshall and Gordon; Nike of Georgetown; Riggs National Bank; Southeast Auto Supply; State Farm Insurance Companies; Texaco Inc.; WGMS Broadcasting Co.; Westinghouse Electric Corp.; and Westvaco Corp.

Publications. Arlington News; Co-ed Magazine; Law Enforcement Communications; The New Prince George's Post, and *The Washington Post.*

Other. Alexandria Archaeology Research Center (Va.); American National Red Cross; Catholic Charities of the Archdiocese of Washington; Folger Shakespeare Library; Forsyth County Heart Association (N.C.); George Washington University Hospital; Model Cities Senior Center (D.C.); St. Columba's Episcopal Church (D.C.); St. Thomas Apostle Catholic Church (D.C.); United Way of America; Visiting Nurse Association of Washington, D.C.; and Washington Hospital Center (D.C.).

4

Preface

Exploring Careers is a career education resource for youngsters of junior high school age. It provides the kind of information about the world of work that young people need to prepare for a well-informed career choice. At the same time, it offers readers a way of learning more about themselves. The publication aims to build career awareness by means of occupational narratives, evaluative questions, activities, and career games presented in 14 occupational clusters. *Exploring Careers* emphasizes what people do on the job and how they feel about it and stresses the importance of "knowing yourself" when considering a career. It is designed for use in middle school/junior high classrooms, career resource centers, and youth programs run by community, religious, and business organizations.

This is 1 of 15 chapters. A list of all the chapter titles appears inside the front cover.

Exploring Careers was prepared in the Bureau's Division of Occupational Outlook under the supervision of Russell B. Flanders and Neal H. Rosenthal. Max L. Carey provided general direction. Anne Kahl supervised the planning and preparation of the publication. Members of the Division's staff who contributed sections were Lisa S. Dillich, David B. Herst, H. Philip Howard, Chester Curtis Levine, Thomas Nardone, Debra E. Rothstein, and Kathy Wilson. Gloria D. Blue, Brenda Marshall, and Beverly A. Williams assisted.

The Bureau gratefully acknowledges the cooperation of all the workers who agreed to be interviewed and photographed, the teachers and students who field tested a sample chapter, and all who shared their ideas with BLS. Many people in the counseling community offered encouragement and support. Special thanks for her generous assistance go to Cathy Cockrill, Career Education Curriculum Specialist, Fairfax County Public Schools, Fairfax, Virginia.

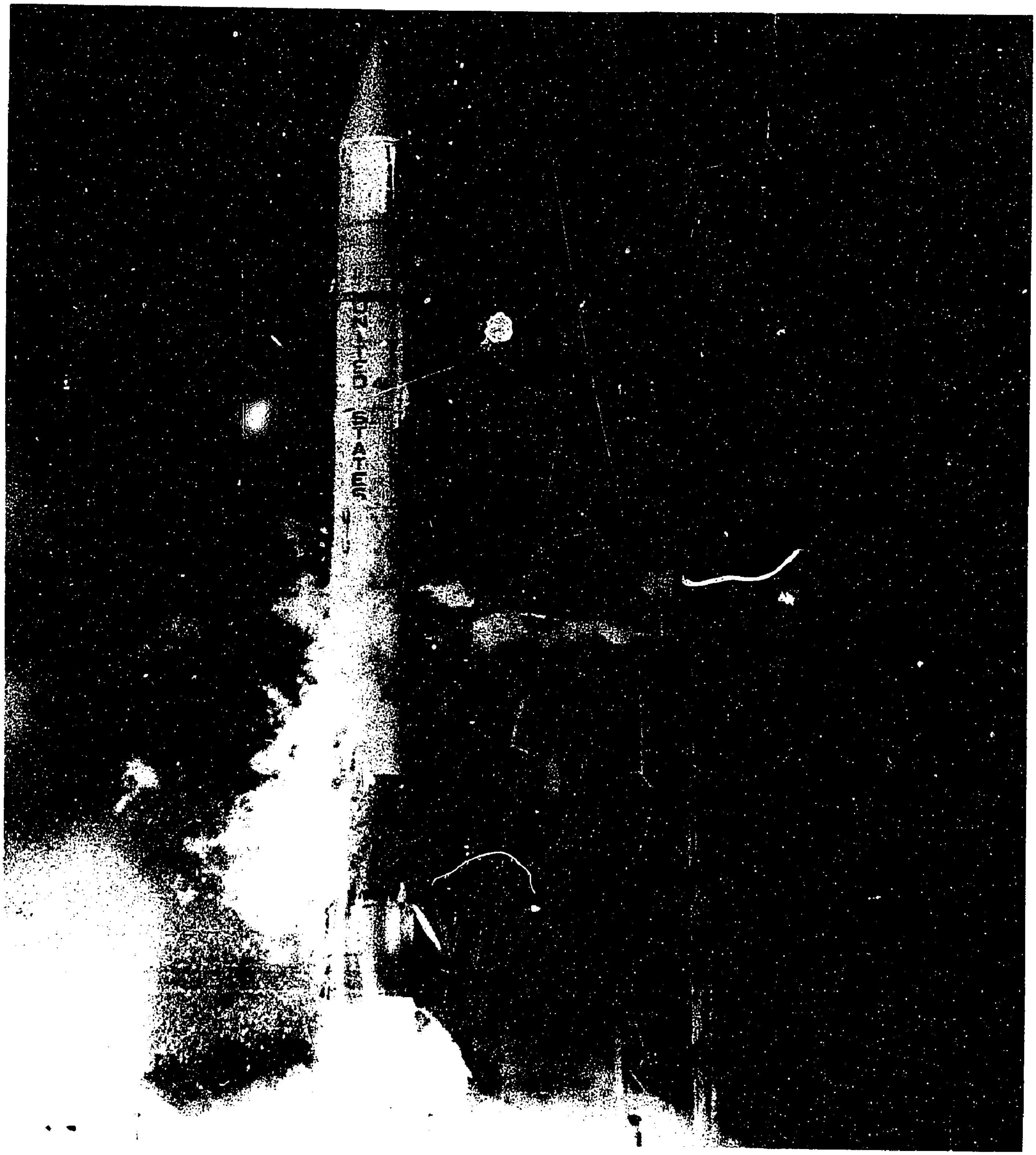
Although they are based on interviews with actual workers, the occupational narratives are largely fictitious.

Contents

6

Exploring Careers

Scientific and Technical Occupations



Once in orbit, the Comstar D-3 satellite will be used for long-distance telephone service.

Have you ever gazed at the stars on a clear night and wondered what's out there? Have you asked yourself what causes volcanic eruptions, earthquakes, or tidal waves? Or wondered why some mothers have twins or triplets? Perhaps you've never thought about these particular things. Undoubtedly, though, something in the world around you has made you stop and search for an explanation. This experience of yours is shared by humans throughout history, from the cave dwellers to your parents and friends.

People have always wanted to understand the universe. Out of this desire has grown the work of scientists, engineers, and technicians. The scientist gathers knowledge, which the engineer applies to practical problems in agriculture, health, energy, transportation, communication, and other fields. Technicians assist scientists and engineers in their work. Let's look at each a little more closely.

Scientists Investigate the Unknown

Scientists study the universe around us to learn why it behaves as it does. They investigate every aspect of our natural surroundings, from the center of the earth to the farthest star. They study things as small as the tiniest nuclear particle and as gigantic as a galaxy. Scientists examine bursts of energy lasting a millionth of a second as well as rock patterns formed over millions of years. Plants, animals, the oceans, the atmosphere all fall under the questioning eyes of scientists.

All scientists gather knowledge through *research*. To understand how, let's pretend you are a scientist trying to solve a problem. How would you go about it? That depends on the kind of problem you have. If you are a biochemist seeking a cure for cancer, you might examine the effects of certain drugs on rats or guinea pigs in a laboratory. But if you are a geologist studying the formation of a mountain range, you might spend much of your time outdoors collecting rock specimens.

No matter what problem you set out to solve, your research will follow certain guidelines. The first step is to learn what is already known about your problem. Your work depends on the work of scientists before you just as each brick of a building rests upon those below it. Without background preparation, you would spend all your time "reinventing the wheel" and have none left for new discoveries.

Once you have learned all you can from others' work, you consider how to solve the problem facing you. Often, the solution will involve some sort of *experiment*. You have probably performed some already. If so, you know that experiments must obey certain rules to be considered reliable.

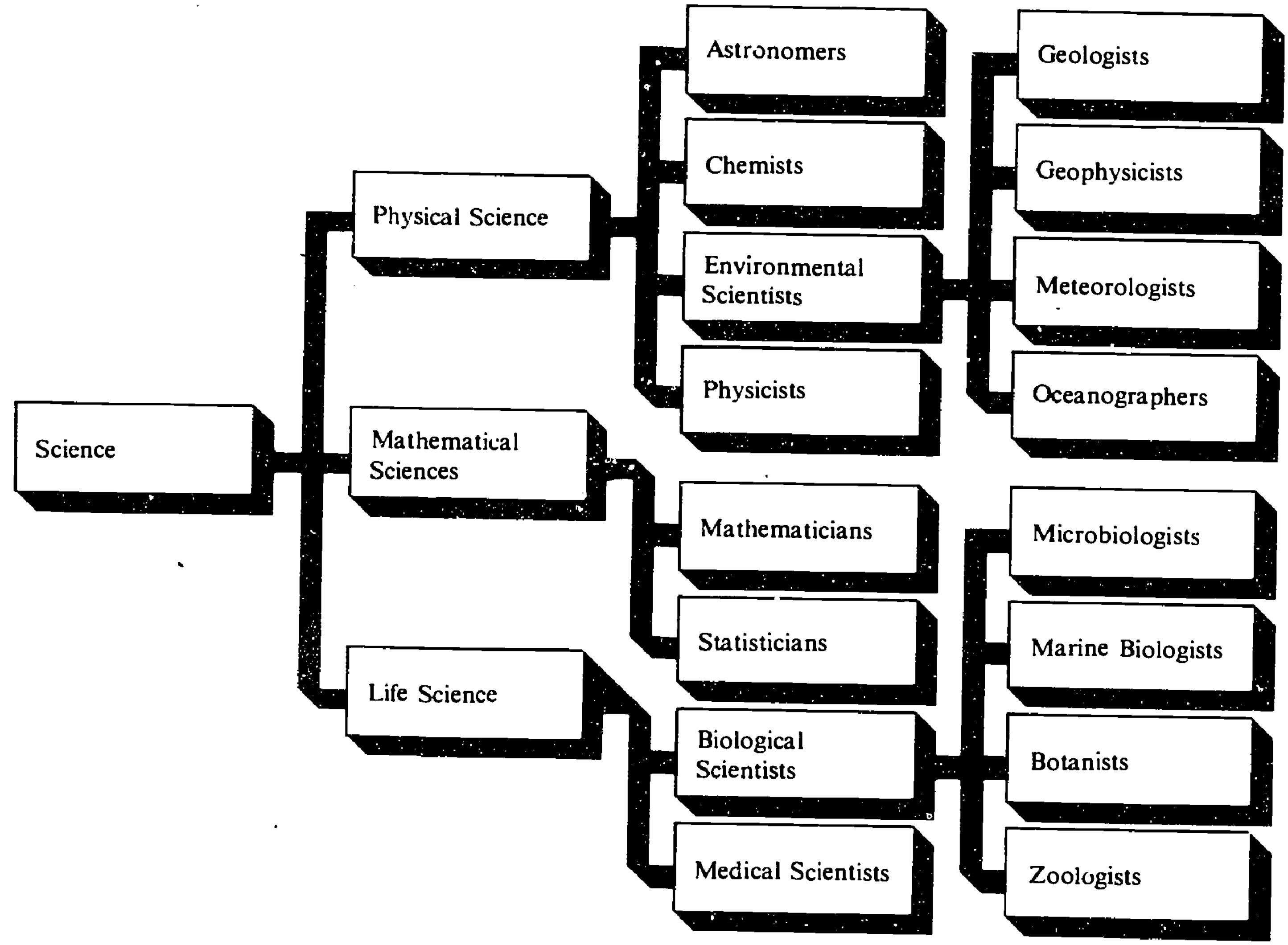
Let's assume that you are the world's leading botanist (plant biologist) and want to determine the best growing conditions for geraniums. If you want to study the effect of water alone, you must keep all other growing conditions—soil, temperature, and light—the same. Otherwise, if a plant grows poorly, how will you know whether it has received too little water or too little of something else? You can use many plants—let's say a hundred of equal size, planted in identical pots and soil. If you grow them in the same place under a fluorescent light, they will all receive the same amount of light and heat. You can group the hundred into tens, giving each group a different daily ration of water. Each geranium in group 1, for example, will receive one tablespoon a day; in group 2, five a day, and so on. Then you watch the plants' progress. As a good scientist, you keep a record of everything you do in the experiment, so that you and others may study it later. You want to measure and record the plants' growth every few days, because you may find the information useful. After several months' growth, you can begin to draw conclusions from your observations. If you find that one group of plants grew fastest during the first weeks, while another group grew fastest during the later weeks, you might conclude that the best amont of water depends upon a plant's size. Perhaps another experiment would tell you more precisely how much water the geranium needs.

You trust your conclusions because you followed rules of experimentation that all good scientists follow:

- Isolating one item to study (in this case, the effect of water on the plant's growth);
- Setting up the experiment to examine only that item;
- Recording your procedure and observations; and, finally,
- Basing your conclusions on evidence from the experiment.

Scientists use the information they gather from experiments to either confirm or deny the *hypothesis* they started out with. A hypothesis is an unproven guess about the results of a particular experiment. A hypothesis that is general enough becomes a theory. Theories are accepted explanations of what is known, but often a new theory will replace an old one as scientists investigate further. Astronomers long believed, for example, that the sun, planets, and stars all revolved around the earth. They constructed elaborate models to explain the movements they saw in the night sky. As new movements were observed, these models became more and more complex. Finally, a Polish astronomer named Copernicus stated a theory that the earth and other planets move around the sun, and the earth turns on its axis. Because it was simpler and more logical, Copernicus' theory

Chart 2. Branches of Science



eventually replaced the old theory as the foundation of astronomy.

What Makes a Good Scientist?

We see that scientists investigate the universe by learning what others already know, performing experiments, and constructing theories that explain the unknown. But what kind of person makes a good scientist? A list of the most important characteristics includes these:

Orderly Thinking. Scientists must be able to analyze problems and information logically in order to draw correct conclusions.

Systematic Work Habits. As we saw, scientists must perform experiments according to certain rules. To do so, they must work carefully and methodically.

The Ability to Work Alone or as Part of a Team. Most scientists work with technicians and other scientists. Cooperation is crucial. At the same time, scientists often work without supervision.

Patience. Some research (such as cancer research) can continue for years without results. A scientist must be able to keep searching for answers, despite occasional frustration.

Above all, *Curiosity.* Scientists have an unquenchable thirst for knowledge, an undying desire to understand the unknown. This intense curiosity inspires them to devote their lives to solving scientific problems, often without the reward of knowing how their discoveries will be used. Many of their achievements do not become important until long after their death. But those scientists continue to explore anyway, driven on by their curiosity.

Chemists must have patience and the ability to concentrate on detail. Experiments may take months to complete.

This botanist specializes in studying prehistoric plants.

Careers in Science

If you choose a career in science, what will you study? Take your pick from the whole universe. As you can see from chart 2, the numerous branches of science all grow out of three basic fields. (See p. 301.)

People in the *life sciences*, the first field, investigate living things. *Biological scientists*, or biologists, want to know how life on earth began, how plants and animals function, and how they reproduce. Biologists usually specialize in a particular group of living things. *Zoologists*, for example, study the animal kingdom, while botanists investigate the plant world. *Marine biologists* examine the living world of the oceans, while *microbiologists* study bacteria, viruses, and countless other organisms around us that we can see only with a microscope.

What biologists learn about living things, *medical scientists* use to understand and control diseases. Medical scientists differ from doctors (or physicians) who normally come to mind when we think of medicine. Medical scientists seek cures for diseases through research in laboratories, while physicians work directly with sick people. The work of physicians is described in the chapter on health occupations.

The *physical sciences*, the second basic field, cover the rest of our physical universe. Here we find *physicists*, who investigate the behavior of light, heat, electricity, magnetism, and gravity. They see how objects behave at very high speeds or very low temperatures. Past research in physics has provided the knowledge needed for such accomplishments as radio and television, nuclear energy, refrigeration, and space travel.

We also find *chemists*, one of the largest science occupations. Chemists study the 103 known elements (and occasionally discover new ones). They examine how these elements combine to form every substance in the universe, what properties they have, and how they react to one another. For example, chlorine and hydrogen, two gases, combine to form hydrochloric acid, a clear liquid that can burn your skin. The same chlorine, however, will combine with sodium to form ordinary table salt. A chemist would want to know how and why chlorine forms two substances with such different characteristics.

Astronomers, the smallest group of physical scientists, study the heavens with telescopes, cameras, and other devices in order to answer age-old questions about the universe: How large is the universe? How were the stars and planets formed? How do they move? What are they made of? And, perhaps most exciting of all, is there intelligent life elsewhere in the universe?

While astronomers look to the stars, *environmental scientists* examine the earth. *Geologists* study the history and composition of our planet. They also examine movements such as earthquakes and volcanic eruptions. *Geophysicists* turn their attention toward the interior of the earth, the movement of the continents, and the earth's magnetic and gravitational fields. *Oceanographers* focus on the oceans, their movements, and the land beneath the oceans, while the atmosphere and the weather are

Entomologists develop ways to encourage the spread of helpful insects and the control of harmful insects.

Geologists study the earth's crust. Their research can help locate oil and other valuable minerals.

the domain of *meteorologists.*

Biological and physical scientists could not have achieved as much as they have without discoveries in the third field, the *mathematical sciences.* In addition to being a science in its own right, mathematics is the language of other sciences. *Mathematicians* study this science of abstract numbers. Most mathematicians develop their theories to solve a specific problem. Many, however, produce theories that find practical use only much later. *Statisticians* develop and use theories that allow scientists to make generalizations about a group of people or objects without studying every member of the group.

Astronomers took this picture of Saturn through a telescope. Careers in science are for people who like to explore the unknown.

We have not named every kind of scientist. There are many more. Some, such as biochemists and astrophysicists, do research in overlapping branches of science. A few scientists move forward in totally new areas of science. . . . This is what an engineer named Karl Jansky did. He discovered that stars give off invisible waves just like the ones carrying music and news to our radios. Other scientists knew about these radio signals from the stars, but nobody paid them much attention. Jansky listened to them with a very sensitive "radio telescope." In this way he began the science of radio astronomy. Progress in science depends upon the pioneers who, like Jansky, break down the old barriers of knowledge and venture forth into unexplored territory.

Many chemists teach in universities.

Engineers Put Science to Work

Did you ever stop to think how many plastic items you use every day? At school you use plastic pens and rulers. You may sit at a desk with a plastic top. In the cafeteria you eat from plastic plates and trays. Perhaps the plates and cups in your kitchen at home are plastic, too. You talk on plastic telephones, listen to plastic records, and use plastic sports equipment. Look around, and see if you can count the number of plastic items in the room you're in right now.

Plastics are just one result of the work of engineers. Others include radio and television, automobiles and airplanes, bridges and skyscrapers, ships and submarines, anything electrical . . . the list goes on and on. Engineers produced all these things by applying scientific knowledge to everyday problems. In fact, most of the discoveries of modern science would have remained laboratory curiosities if not for engineers.

To do their jobs well, engineers must be creative.

What Do Engineers Do?

Engineers begin with a "how to" problem—how to build a bridge, how to increase the output of a factory, or how to turn sunlight into electricity. Like scientists, they do research to find a solution. In designing a supersonic airplane, for example, aeronautical engineers test different airplane shapes in a wind tunnel to see how they behave at high speeds. Such tests help them decide on the best design before actually building the plane. Similarly, civil engineers make models of various bridges to test each design for strength.

Through research, engineers find scientific answers to the "how to" problem. But finding a solution that works is only the beginning. Engineers also must figure out the cost and difficulty of using that solution. Imagine you are a civil engineer designing a subway tunnel for a large

Engineering careers are for people who like to solve problems.

city. You have designed a tunnel that you think would work very well. But you would not have solved the city's problem if your tunnel would cost twice what the city could afford, or if large buildings had to be moved to build it. You have to make sure that your solution to the problem is *economical* and *practical* as well as technically correct.

How do engineers solve problems? They use tools of various kinds, the most important being analytical tools. Analytical tools permit engineers to reshape their problems into manageable forms, and this helps in the search for a solution. Mathematical models are one such analytical tool. The model that an engineer builds is nothing more than a set of equations that describes the problem mathematically. By building a model, an engineer can examine the effects of changes in different parts of the final product.

Engineers also employ equipment of all shapes and sizes for measuring, calculating, and testing. Some devices, such as wind tunnels, serve a very specialized purpose. Others, such as calculators and oscilloscopes, you would find in the laboratories of many kinds of engineers. Some tools remain in the lab; others are used outside, "in the field."

The computer is very important. It can perform calculations that are too long or involved to do by hand. It can handle hundreds of equations at once, so that the engineer can build larger, more complex mathematical models. It can also be used to actually help design whatever the engineer is trying to create.

Engineers rely on one other important tool: Creativity. Unlike math, creativity can't be taught. But good engineers have it and use it to apply science in new, slightly different ways. Although engineers rely heavily on the work of others (such as scientists), they constantly face problems requiring original solutions. They discover, explore, invent, and devise. To do their job well, they must be creative.

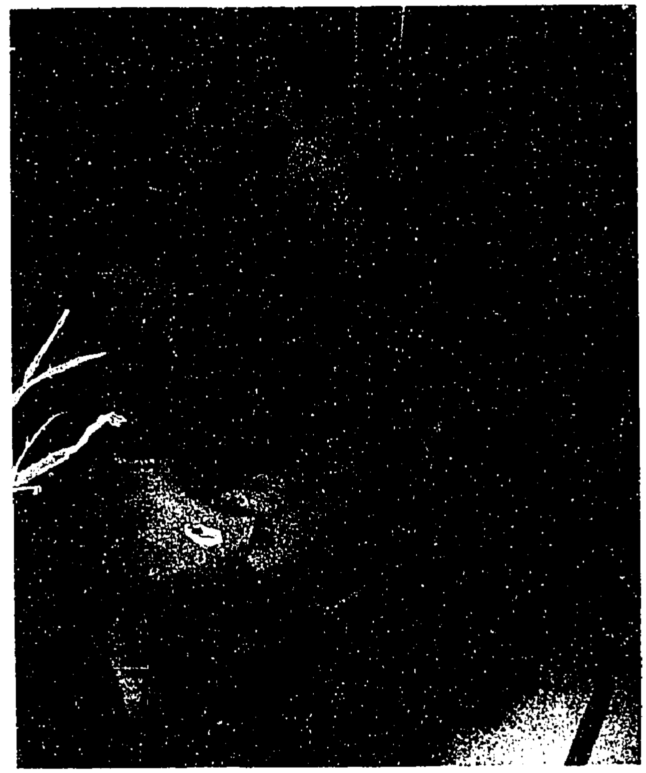
Careers in Engineering

If you decide on a career in engineering, you can choose from a wide variety of fields. They are as diverse as the needs of society. Some types of engineers specialize in a particular industry. *Agricultural engineers*, for example, develop ways to produce, process, and distribute food more efficiently. They might design new harvesting equipment or a better canning process. *Chemical engineers* create plastics, synthetic fabrics, and other new materials through chemical processes. *Mining engineers* locate minerals in the ground, design mines, and make sure they operate safely. They also devise ways to transport the minerals to processing plants. *Petroleum engineers* perform a similar role for oil and gas products.

Other engineers specialize in a particular type of technology. *Mechanical engineers*, one of the largest groups, design and develop machines that produce or use power. Every day we rely on such machines—cars and trucks, refrigerators and TV sets, heaters, air conditioners, factory machines, and countless others. Mechanical engineers help create and produce all these machines as well as gasoline engines, steam turbines, jet engines, and nuclear reactors. Some mechanical engineers specialize by concentrating on a single type of machine (such as a jet engine) while others specialize in a single industry (such as the automobile industry).

Electrical engineers, another large group, design and develop electrical and electronic devices. Anything that uses electricity is electrical. Electronic machines—such as radios, TV's, telephones, and computers—convert electricity into sound, radio waves, or some other form of energy. Like mechanical engineers, electrical engineers work in many different industries and usually specialize in a particular area.

Astronaut Guion S. Bluford, Jr., has a doctoral degree in aerospace engineering.



By studying collisions in the lab, engineers and scientists can design safer automobiles.

The world of flight is the world of *aerospace engineers.* They deal with every aspect of aircraft and spacecraft performance, from planning and design to production, testing, and actual use. *Biomedical engineers* use their engineering skills to improve health care in many ways, such as by designing artificial organs or by adapting computers for use in hospitals. *Ceramic engineers* design and develop products from ceramic materials, which are nonmetallic substances processed at high temperatures, such as glass or porcelain. *Metallurgical engineers* cover the broad technology of metals—understanding their properties, extracting them from the earth, refining them, and converting them into finished products.

Other engineers work in construction and a wide variety of industrial activities. *Civil engineers* design large facilities such as highways, railroads, bridges, airports, and water and sewage systems. *Industrial engineers* are "the manager's engineers." They look for ways to make factories and other business operations run more smoothly and efficiently.

We have mentioned only the major categories of engineering. We could not possibly describe each individual specialty. Not only are new ones created all the time, but every engineer's craft is slightly different, depending upon his or her particular training and job. Within the few engineering occupations mentioned there are hundreds of specialties.

Technicians Perform the Practical

We have said that scientists and engineers work as part of a team. Who are the other members of the team? Many are technicians.

But what is a technician? The word (along with the words *technical, technology*, and *technique*) comes from a Greek word meaning *skillful* or *practical.* And there you have the key: Technicians perform the practical aspects of a job, leaving theory to the scientists and design to the engineers. They are the "doers."

Technicians perform the day-to-day tasks necessary in creating a new project or running an operation. They operate testing and measuring equipment in a laboratory. They make drawings of new designs. They build physical models of new projects. They estimate the cost of a project and the amount of materials and labor needed to complete it. They inspect a manufacturing plant to see that the product's quality stays high. They repair machines that break down. They may act as sales representatives, selling products like airplanes or computers.

What Makes a Good Technician?

Evey branch of science and engineering has its technicians. Just listing their titles would take several pages. All of them have certain qualities in common:

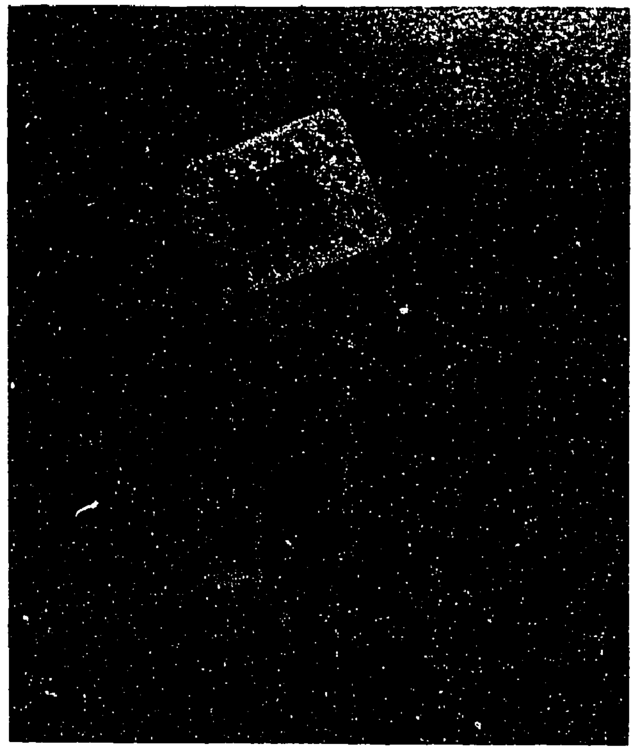
Basic Background. Technicians have a good foundation in math and the basic sciences—physics, chemistry and/or biology. But they learn more practical problem-solving and much less theory than a scientist or engineer.

A "Head" for the Practical. Many technicians use theoretical knowledge in their work, but most of what they do is of a nuts-and-bolts nature.

Patient, Systematic, Precise Work Habits. Often a technician must repeat a test many times in exactly the same way, or perform a task within very narrow standards. These require reliable work habits.

Ability to Work Under Pressure. In many kinds of work, if something important goes wrong, the technician must think and act quickly without panicking and without making mistakes.

Good Hands. Technicians build, use, and repair equipment and do many other tasks that require them to be good with their hands.



Developed by electronics engineers, this tiny device made possible TV cameras no larger than a deck of cards.

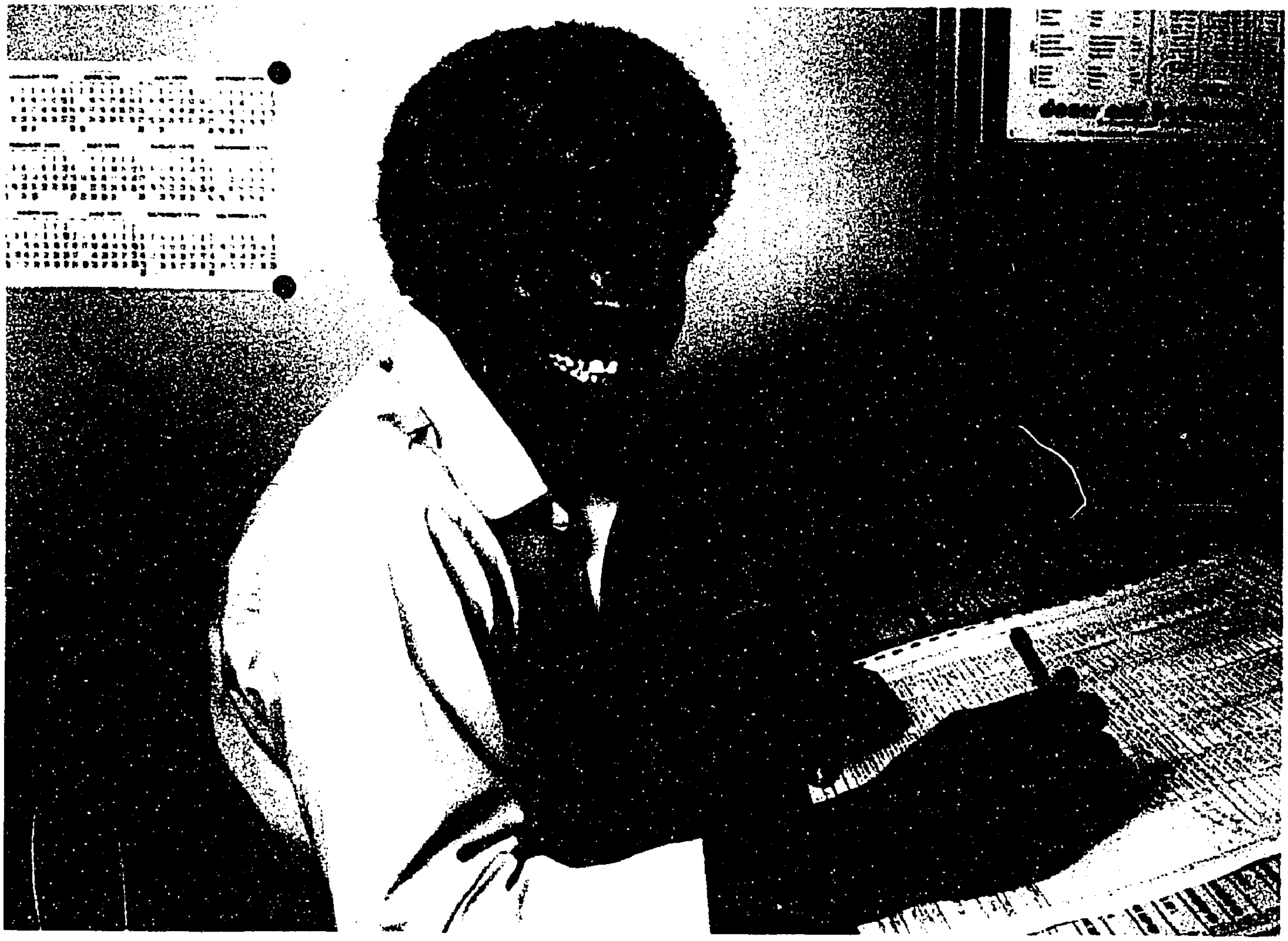
Training for Scientific and Technical Occupations

How would you train for a career as a scientist, engineer, or technician? You may already have begun. If you have hobbies related to science or engineering you already are gaining valuable experience. Using a chemistry set, building radios, fixing bicycles—activities such as these teach skills that could be useful in science or engineering occupations. Do you like to go to museums to learn about the stars, the oceans, or natural history? You may already have begun your science education.

Formal training in science begins in high school. You should take as much math as possible, as well as basic science courses—biology, chemistry, physics, earth science. Your high school probably offers other classes, such as electronics and drafting, that would be useful in some career fields. English courses are important, too, since scientists, engineers, and technicians must be able to communicate clearly with their co-workers, both orally and in writing.

Most of your training, of course, would occur in college. Scientists and engineers generally earn a bachelor's degree after 4 or 5 years' study, and then go on to

A biomedical engineering experiment.



Drafting can be a career for people who like to draw.

graduate school, if necessary. Today, most science occupations require a Ph.D. Fewer engineers than scientists need a doctorate. Most find work with a bachelor's or master's degree. For teaching or for advanced research, however, the Ph.D. is essential. Technicians usually spend 2 years in special technical training programs after high school, although some have 4-year degrees.

Training does not end when you earn a college degree. New discoveries occur so often that what you learn in college soon will become outdated—though not useless. Just as you can expect to learn new words your whole life, scientists, engineers, and technicians continue to learn new theories and applications their entire lives. They learn by reading books and magazines, going to conferences, and attending occasional seminars. Careers in science are for people who like to learn outside as well as in school.

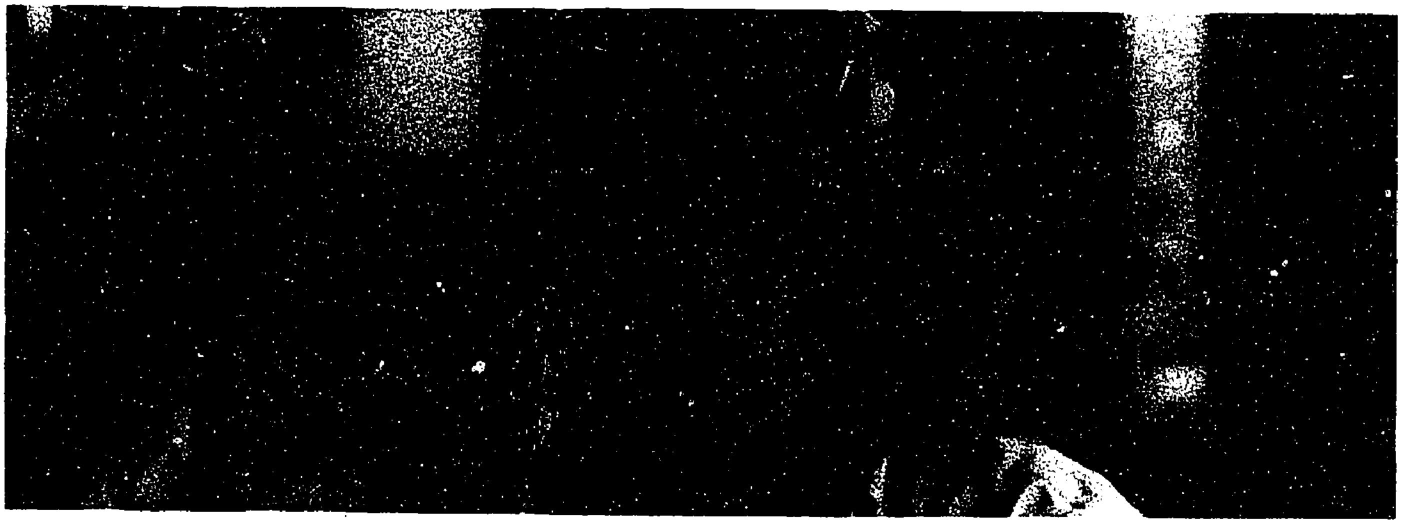
A Final Word

If you have a strong interest in science or mathematics, don't stop here! Several other chapters of *Exploring Careers* are worth looking into.

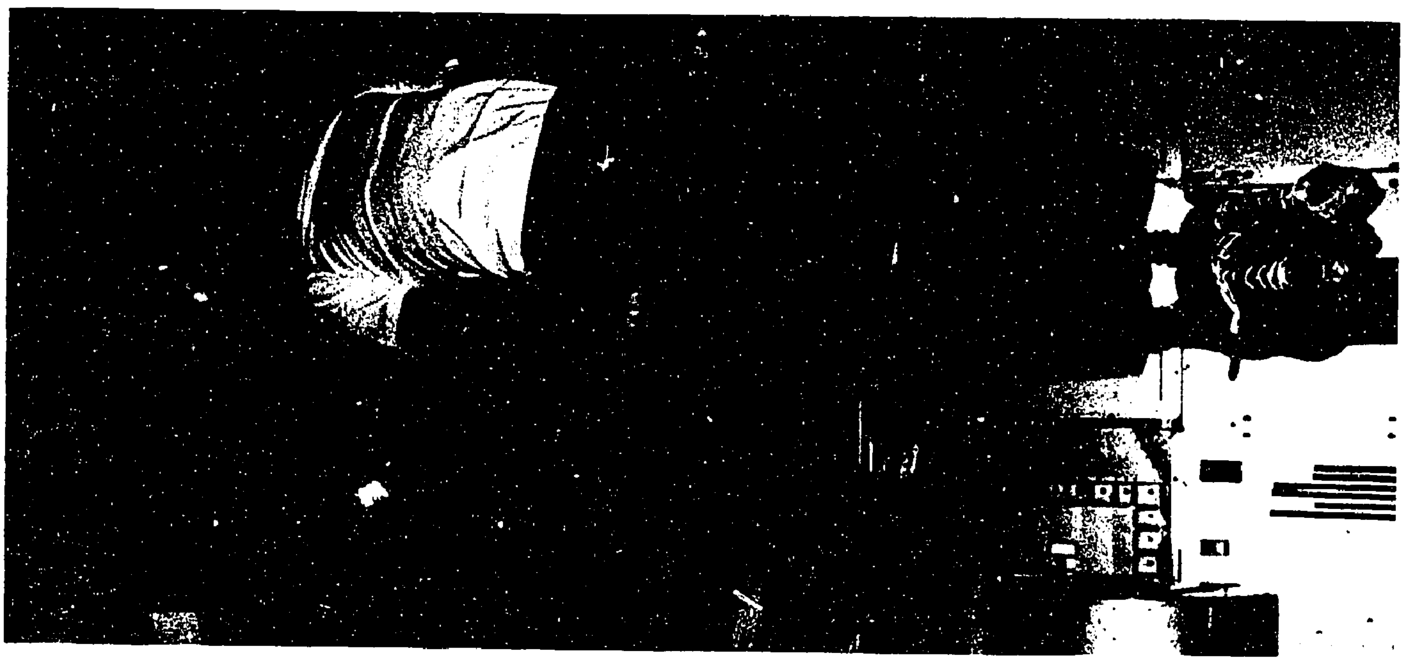
There is a chapter on Health Occupations, many of which require a sound grasp of biology and chemistry and the ability to draw on scientific principles in dealing with day-to-day health care.

Students who are good in mathematics or physics might want to learn more about a career in architecture. This field, like engineering, involves an understanding of materials and their properties. A story about an architect appears in the chapter on Performing Arts, Design, and Communications Occupations. A field closely related to both architecture and engineering is urban and

Scientific and Technical Occupations



Technicians assist scientists and engineers. "Technician" comes from a Greek word meaning practical skill.



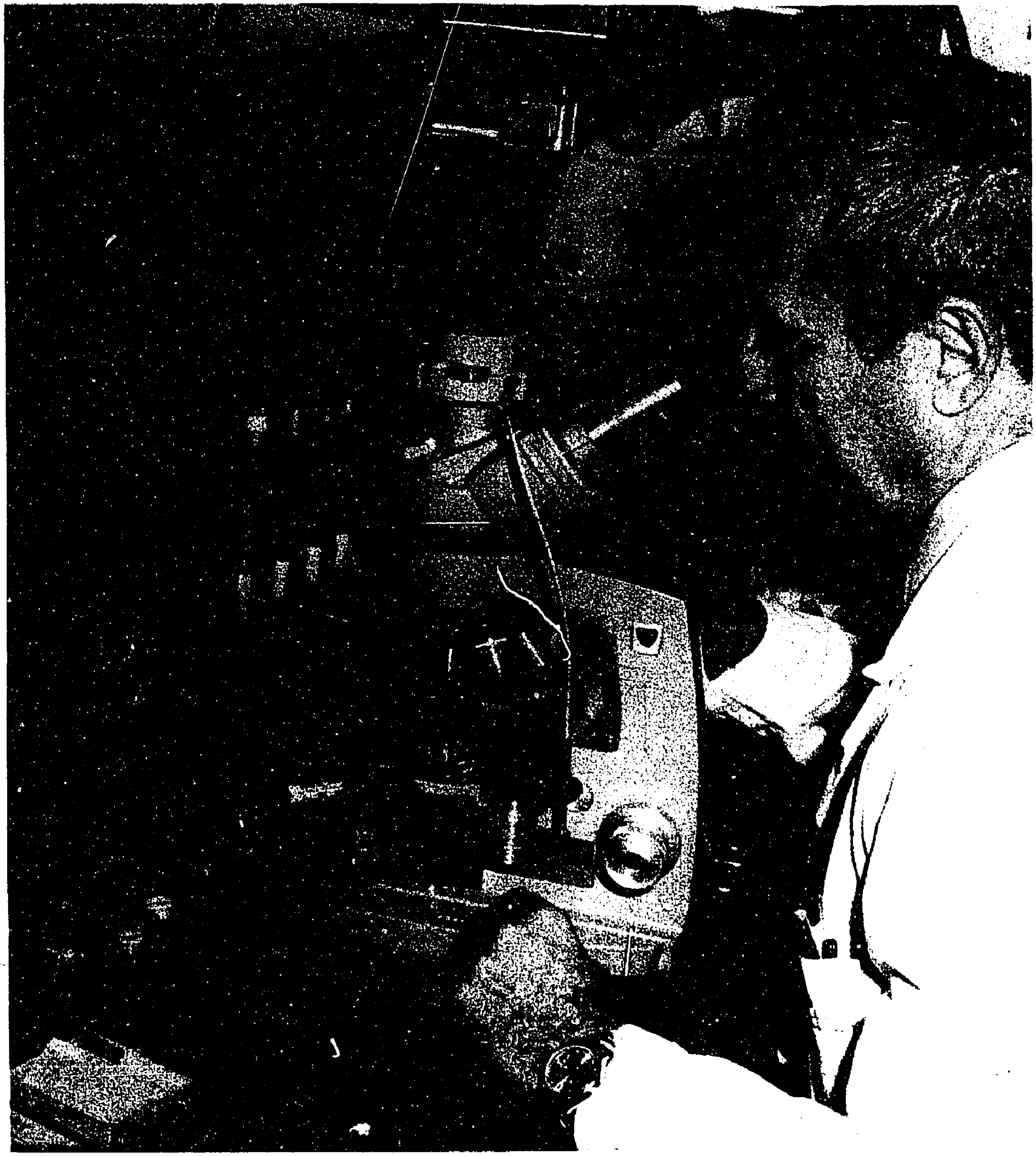
Astronauts demonstrate zeroing effects on weight.

regional planning. A story about a planner appears in the chapter on Office Occupations.

Interested in computers? You may already know of the broad range of scientific and technical jobs in the field of computer science, including programming, systems analysis, and computer design. To learn a little more about this field, read the story about the programmer/systems analyst. This, too, is in the chapter on Office Occupations.

Did you know that it takes more than an interest in the environment and the outdoors to become a forester? Scientific training is important, too. A story about a forester appears in the chapter on Agriculture, Forestry, and Fishery Occupations.

Biochemist



Dr. George Catravas' plans took several twists and turns before he decided on chemistry. "I didn't even like chemistry in high school," he recalls.

George Catravas works in a special world. He wears a white coat. He walks on concrete floors in large rooms with cluttered counters and cabinets. He works at tables covered with glassware, hardware, and plastic tubes. He handles mice and rats in cages. He uses large machines with long names like "analytical ultracentrifuge" and "recording spectrophotometer."

Most of us never see this world.

At the same time, he works in a world common to all of us. His is the world of the cell, the basic unit of life.

George Catravas is a biochemist.

As chairman of the biochemistry department at the Armed Forces Radiobiology Research Institute in Bethesda, Maryland, Dr. Catravas has many duties. He plans, supervises, and coordinates activities of the whole department. Now and then he teaches at a nearby university, which he enjoys.

But most of all he loves research. "Molecules don't cheat," he points out. "They remain the same, waiting for you to figure them out."

As the Institute's name suggests, Dr. Catravas studies radiation and its effects on humans and other animals. People receive doses of radiation from many sources. Every day we all absorb small amounts of natural radiation from outer space and from radioactive minerals, such as uranium, in the earth. Radiation also comes from X-ray machines, nuclear reactors, and other places where radioactive materials are used. "Radiation" actually means any of a whole variety of energy rays, including visible light, ultraviolet light (the kind made by sunlamps), heat, radio waves, and others. Most of these rays are harmless to living things. Many kinds, however, such as X-rays and gamma rays, can be dangerous. These dangerous rays are the ones studied at the Institute.

Radiation can cause cells to reproduce in a new form and become cancerous. Dr. Catravas and his colleagues want to know exactly how this occurs. The damage depends on the type of cell as well as the type and intensity of radiation. When they understand this process well enough, they will better understand how to protect people from harmful radiation and how to use radiation for beneficial purposes.

Dr. Catravas and his team of workers have several different projects in progress. He himself spends most of his time studying how radiation and certain drugs affect the cells of the brain. He also takes part in projects to answer other questions, such as how radiation affects liver cells, how it can be used to treat cancer, and how we can protect ourselves from it.

Before beginning an experiment, Dr. Catravas, like any good scientist, must plan. He and his assistants decide exactly what they hope to learn and how this experiment will give them their answer. They then discuss what they will need. What kind of animals should be used? How much radiation should they be exposed to and for how long? Must anything be done to the animals beforehand? When and what will they be fed?

Dr. Catravas explains all the details of the experiment to his laboratory technicians so that they can perform the necessary steps, with his help and guidance. He will perform especially delicate experiments first, while his assistants look on. But, being a teacher as well as a researcher, Dr. Catravas gives his helpers as much responsibility as possible so that they may learn by doing.

How does the actual experiment proceed? In studying the cells of the cerebral cortex of the brain, for example, Dr. Catravas may decide he needs only a few milligrams of brain tissue for each of three or four types of analysis he wants to perform. One mouse is enough to provide that amount. The Institute buys rats and mice from companies that breed them especially for laboratory purposes, and has its own veterinarian to keep them free of disease.

Dr. Catravas selects his mice at random for the experiment and feeds them. He places them in small cages that confine their movement, so that they will receive a uniform dose of radiation. He then puts the cages in a large chamber where they will be exposed to X-rays. He may decide to expose them for 90 minutes a day for 7 days, or for some other length of time.

Once he has exposed the mice, he has them dissected and their cerebral cortexes removed so that their cells can be examined. He uses biochemical techniques to separate the cells into their parts, in order to look at each. First he uses chemicals that break the membrane, or outer covering, of each cell. Then he puts the sample in a centrifuge, a machine that spins the sample at very high speeds, the way you might swing a ball in a circle on a length of string. The centrifugal force pulls the heaviest part of the cell. the nucleus, closest to the bottom of the tube, away from the center of the machine. Lighter parts of the cell migrate toward the middle of the tube, while many of the enzymes remain at the top. In this way the centrifuge creates layers in the tube, with each layer containing different parts of the cell. Using this and other sophisticated techniques, Dr. Catravas can separate the cells into their various parts.

Next, he examines the parts by using other instruments. One instrument, the electron microscope, allows him to view parts of the cell too small to be seen through normal microscopes. Another, called an analytical ultracentrifuge, photographs the cell molecules in ultraviolet light as they are spun to see if they are broken. These and other techniques allow Dr. Catravas to study the damage caused by the radiation.

An experiment may require several weeks to complete.

After it is finished, Dr. Catravas again meets with his co-workers, this time to discuss the results. Did the experiment run as planned, or should it be repeated? Should it be changed and rerun? Did a new factor appear that requires fı ˙ɩer study? What new experiments are needed? With each experiment the researchers come closer to the answers they seek.

How does one become a biochemist? Dr. Catravas' own path took several twists and turns. His background includes some training in law, as well as separate degrees in chemistry, biochemistry, and organic chemistry. He studied and taught in Greece, Germany, England, and France before coming to the United States to do further study and research at the University of Chicago. After 7 years there, he left to join a company that makes laboratory instruments. Several years and a few inventions later, he moved to his present position.

You needn't study in as many places nor take as many degrees as Dr. Catravas to find interesting work in biochemistry. Some of his assistants, for example, have bachelor's degrees, while others have master's degrees. They all learn on the job as well as in school. But Dr. Catravas points out that, to reach positions of responsibility in this field, you should have a Ph. D. degree. That may seem like a mountain of work, but it can also be a short beginning step in a long, satisfying career.

Just ask George Catravas.

Exploring

Biochemists are curious about the wonders and mysteries of life.

- Do you enjoy looking at ordinary living things, such as leaves, insects, and flowers, through a magnifying glass or microscope?
- Do you try to learn more about what you see?
- Do you wonder what your body, the earth, or the stars are made of?

Biochemists continue learning all their lives.

- Do you like to read?
- Do you look up words you don't know in a dictionary?
- Do you like to browse in the new book section of your library?
- Do you belong to a science club?

Biochemists must think like detectives to solve the mysteries of science.

- Do you like to solve puzzles, riddles, and brain teasers?
- When you don't understand something, do you try to figure it out before asking for help?

Biochemists work with numbers and advanced mathematics.

- Do you do well in math?
- Do you enjoy working with numbers?
- Do you like to calculate sports statistics or automobile mileage?

Biochemists do experiments that may take weeks, months, even years to finish. They must be very patient.

- Do you enjoy crafts such as paint-by-numbers or needlepoint?
- Do you like to do large jigsaw puzzles?
- Do you like long projects such as growing vegetables or putting on a play?

Biochemists pay attention to detail when they do research.

- Can you follow the instructions correctly when you build a model airplane, assemble a radio from a kit, make a casserole, sew clothes from a pattern, or put together a bicycle from parts?
- Can you give detailed instructions?
- Can you read a road map?

Suggested Activities

If you live near a chemical, pharmaceutical, or textile manufacturer, or some other company with a chemical research laboratory, arrange a tour of the lab for your class. Find out what kinds of experiments the scientists perform, what procedures they follow, and what equipment they use.

Prepare a report for your science class on one of the following topics:

- The periodic table of elements. As you read and explore, try to answer these questions: What is an element? How does it differ from a compound? What do the numbers in the table stand for? Why is the table arranged the way it is? (Hint: What do the elements in each column have in common?) Your science teacher and school librarian can suggest books that will help you answer these questions.

Dr. Catravas loves research. "Molecules don't cheat," he points out. "They remain the same, waiting for you to figure them out."

- The chemicals used in the human body. What elements does your body need to live? How does it take them in? What does it do with them? Make a chart to show how your body obtains and uses oxygen.
- Animal cells. Make a drawing of a typical animal cell, labeling all the major parts. What purpose does each part serve? How does an animal cell differ from a plant cell? What different kinds of cells are found in the human body?

Exploring Careers

Learn about life science on your own by trying these activities:

- Keep an aquarium or terrarium.
- Watch TV specials about wildlife, medicine, and other life science subjects.
- Check your library for articles of interest in *Science News, Scientific American,* and other science journals.
- Visit nature or wildlife centers in your area. Call the local department of parks and recreation to find these centers.

If you are a Boy Scout, try for merit badges in Botany, Zoology, Chemistry, and General Science.

If you are a Girl Scout, see if you local troop has the From Dreams to Reality program of career exploration. Troops may also offer opportunities to try out careers through internships, service aide and community action projects, and proficiency badges in a number of areas including Animal Kingdom, Plant Kingdom, and Science.

Join a Marine Science, Conservation, or Ecology Explorer Post if there is one in your area. Exploring is open to young men and women aged 14 through 20. To find out about Explorer posts in your area, call "Boy Scouts of America" listed in your phone book, and ask for the "Exploring Division."

Invite a biologist, chemist, or biochemist to speak to your class about his or her work. Prepare questions for the speaker in advance.

Report to your class on the different kinds of work performed by biologists and chemists. Draw a diagram to show the various branches of each science describe the work of each branch, and point out where the two sciences overlap. One way to investigate is to write for career information to the American Society of Biological Chemists, 9650 Rockville Pike, Bethesda, Maryland 20014.

Related Occupations

Biochemists are not the only scientists who deal with living things. Several other kinds of scientists are listed below, along with possible descriptions of what they do. For each occupation, see if you can choose the correct description.

1. Agronomist

a. Improves the quality and yield of agricultural crops.
b. Studies the different species of spiders.
c. Performs research on agronomes, which are part of the nucleus of a cell.

2. Microbiologist

a. Develops new ways to use the microscope in biological research.
b. Breeds plants and animals in order to produce smaller varieties.
c. Studies the growth and characteristics of bacteria, viruses, and other microscopic organisms.

3. Pharmacologist

a. Investigates the effects on animals of drugs, poisons, and other substances.
b. Breeds new and better varieties of animals for food.
c. Decides what medicine each patient in a hospital should receive.

4. Pathologist

a. Studies the migration patterns of animals.
b. Investigates the effects of diseases, parasites, and insects on human cells, tissues, and organs.
c. Performs research on the relationship between mental disorders and criminal behavior.

5. Embryologist

a. Studies the causes and effects of genetic defects.
b. Investigates the development of an animal from fertilization through pregnancy.
c. Searches for a cure of cancer.

6. Organic Chemist

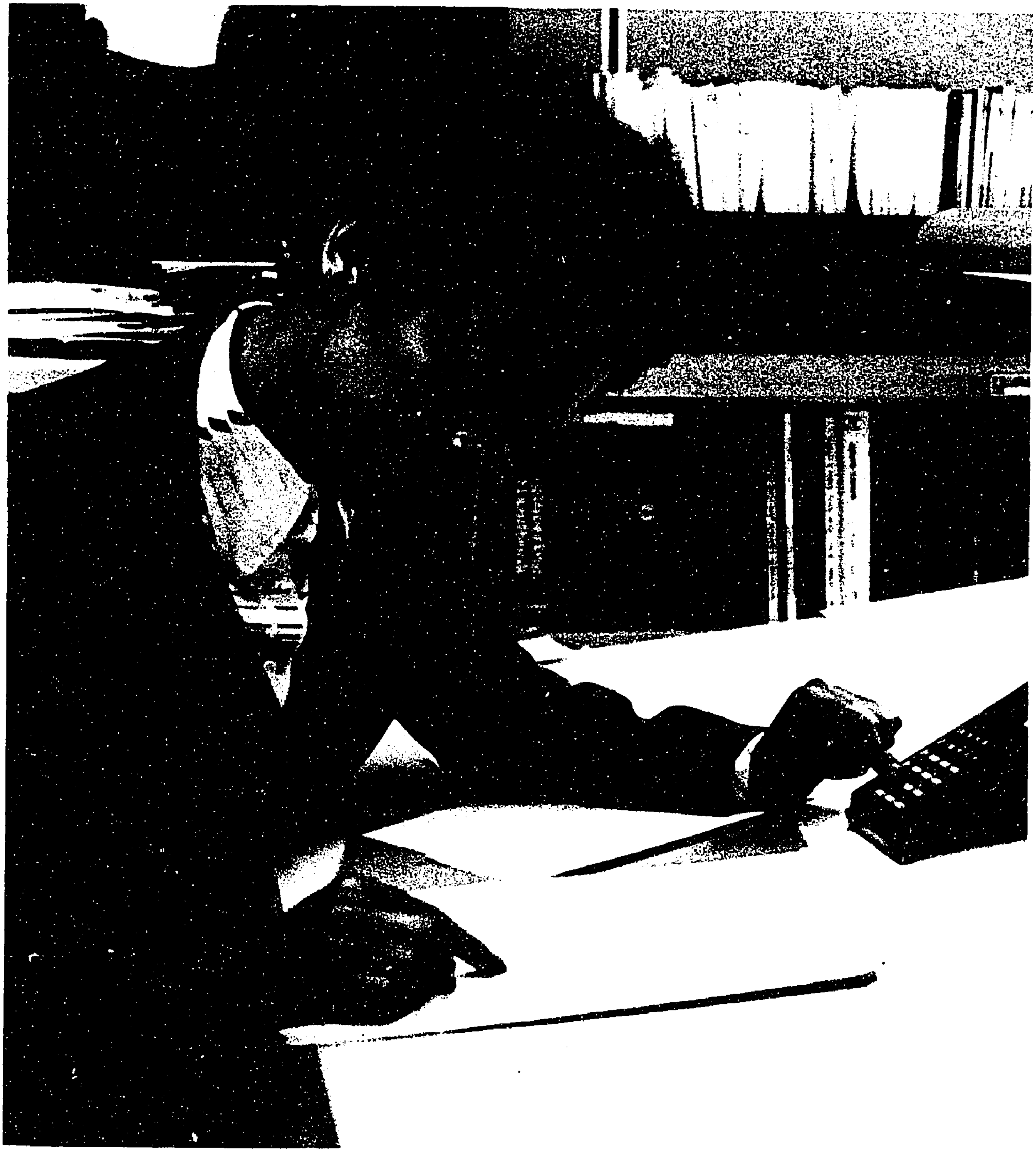
a. Creates new chemical substances from plants.
b. Analyzes the chemical processes that take place inside the kidney, liver, and other human organs.
c. Studies the structure and properties of compounds containing carbon.

7. Horticulturalist

a. Develops new and better methods of cultivating plants for orchards and gardens.
b. Studies the social structure of bee colonies.
c. Grows mold cultures in a laboratory in order to make penicillin.

See answers at end of chapter.

Electrical Engineer



As vice-president in charge of engineering, Gloria Blue uses her talents to develop new hi-fi products.

Gloria Blue pulled into her parking space and turned off the engine. Climbing out of the car, she noticed how warm the morning was. Although she had moved to Los Angeles from Chicago over 6 years ago and should have been used to the weather by now, spring-like days in November still seemed odd.

Gloria entered the modern brick building with the sign above the double glass doors that read "Auto Fidelity Inc." After greeting the receptionist, she stopped to chat with another co-worker before climbing the stairs to her own office, the one marked "Vice-President of Engineering."

Laying her briefcase on the table, Gloria ran over the day's work in her mind. Normally Friday was the easiest workday, but there'd be plenty to do today before going home for the weekend.

Auto Fidelity Inc., known as AFI, is one of the nation's leading distributors of sound equipment for cars and other vehicles. AFI manufactures radios, tape players, speakers, and other products and distributes them to stores and dealers across the country. As Vice-President of Engineering, Gloria Blue uses her electrical engineering skills to develop new products that meet the needs of customers. She is the bridge between the technical side and the sales side of AFI's business.

Armed with a cup of coffee, she sat down to the first task of the day—completing a technical bulletin she had begun earlier in the week. Since many car owners install two pairs of speakers in their cars instead of just one, Gloria and her staff had designed a new connector plug that allows the customer to connect all four speakers to the radio without splicing wires. But AFI couldn't get its sales campaign underway until the sales staff understood what the new connector could do, and what advantages it offered. Gloria's bulletin would explain all this to the sales people.

She had nearly finished writing it when Bob Cohen, chief design engineer, called. "Come on down to the lab when you have a chance," he said. "I've finished the model of the equalizer."

"I'll be right down," answered Gloria, anxious to see Bob's results.

Bob was leaning over a table, changing a few details on a drawing, when Gloria walked into the room. "It's over here," said Bob, turning to one of the metal workbenches littered with electronic devices, handtools, wires, half-dismantled radios, and loose parts. He picked up a small metal box with several knobs on one side and handed it to his boss. Removing the top and examining the box closely, Gloria commented, "I think we have a winner."

The equalizer was one of her better ideas. She had followed trends in the home stereo equipment market as well as in the automobile products sold by AFI's competitors. From all she had seen, Gloria felt that the public would buy a combination power booster and equalizer. The booster would increase the loudness of a radio or tape player, while the equalizer would allow the listener to adjust the volume of the treble, middle, and bass tones individually, thus "equalizing" the sound. No other company offered such a product for automobiles.

After creating the general concept, Gloria had handed the idea to Bob and his staff, who actually designed the device. They figured out what parts to use, arranged them in a package, and tested it. But they worked under the guidance of Gloria, whose job it was to make sure the product would be attractive, reliable, and inexpensive.

Gloria and Bob, both electrical engineers, performed quite different engineering jobs at AFI. Bob's position was purely technical, while Gloria had moved into a management job. The work was a far cry from what she had dreamed about as a teenager.

When she was in junior high, Gloria was sure she'd be a nurse one day. Her favorite aunt was a head nurse at one of Chicago's largest hospitals, and Gloria enjoyed talking with her about the job. By her senior year in high school, she had changed her mind. A long talk with her guidance counselor encouraged her to think about a career that involved mathematics; Gloria always had made excellent grades in math. So she started college with plans to become a math teacher.

That fall she met her husband-to-be, Larry, who was a junior at the engineering school. They frequently studied together and discussed their courses. Gloria grew more and more interested in Larry's engineering problems, and liked trying her hand at solving them. Before the school year was over, Gloria had decided to switch to electrical engineering. It took all summer to sell her parents on the idea but they finally agreed that the decision was hers to make. Gloria recalls how proud they were when she received her bachelor's degree in engineering.

Gloria started out in the research and development division of a large manufacturer of electrical products in Chicago, and spent the next 10 years there. She developed a solid reputation in the area of product development. At the same time, she was attending evening classes in business and management to earn a master's degree in business administration. This combination of technical and nontechnical skills made her just the right person for the California job advertised by AFI.

Gloria and Bob discussed the equalizer for almost an hour. Once the company's designer developed the cosmetics, or outer appearance, for the product, the factory could begin producing it. Then, after testing, it would appear in the stores. Gloria looked forward to that day; of all the things she did for AFI, she most enjoyed seeing an idea grow into a successful product.

On her way back to her office, she bumped into Jim Leviton, the company president. "By the way, Jim," said Gloria, "I've looked at that new spectrum analyzer that California Instruments makes and read the literature on it. It can test a radio in about 2 seconds, much faster and better than we can now. And even though it costs $6,000, we need it badly for our laboratory."

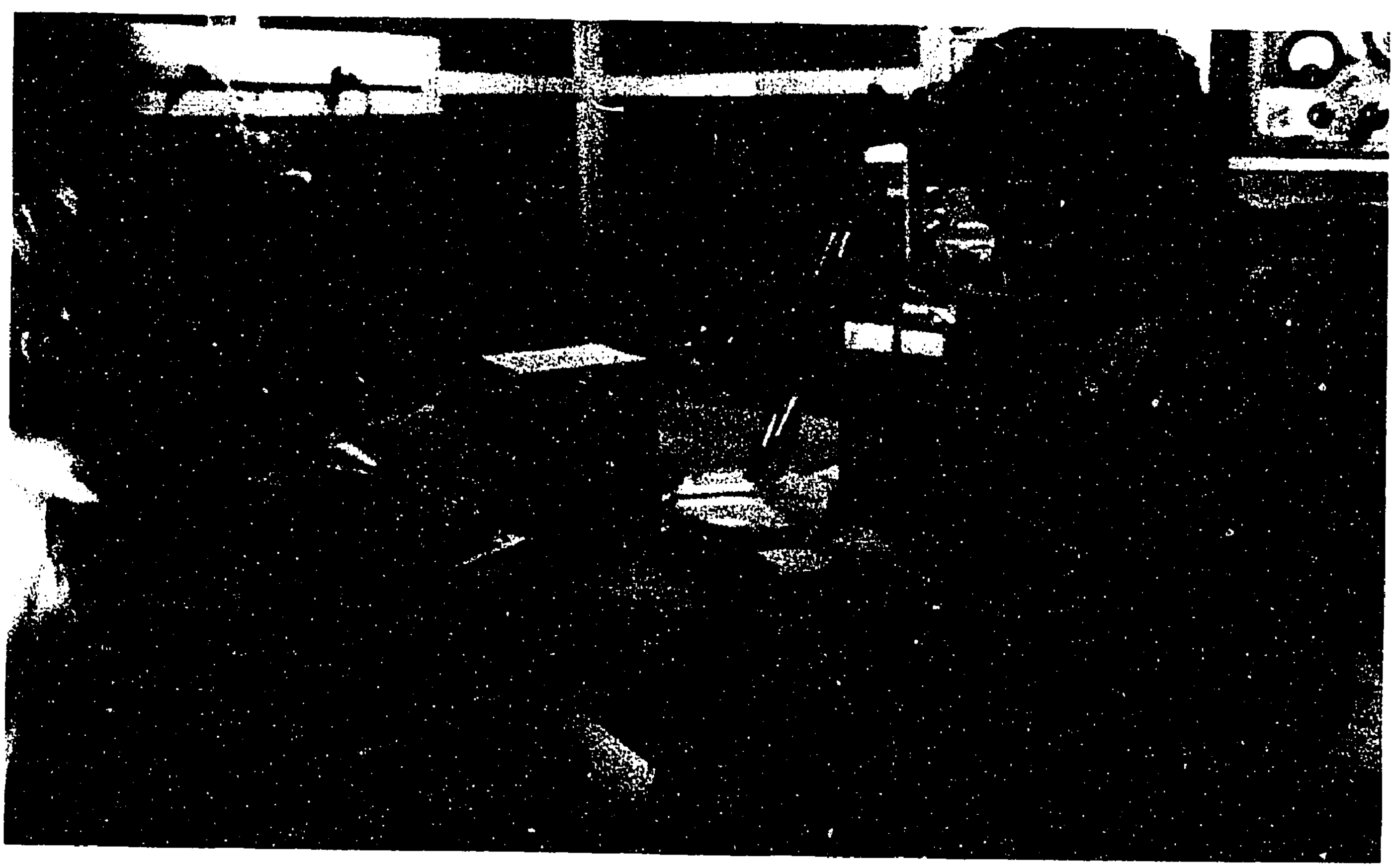
"Let's get together with Al and decide if we can afford it," answered Jim. "How about this afternoon?"

"Fine," replied Gloria, "as long as we don't talk too long. I'll have that sales bulletin on the connector done before lunch, but I still have some preparing to do for Monday's meeting with Toshiro."

"That meeting will be a long one," thought Gloria. Hero Toshiro is an engineer who works with the manufacturing division of AFI. Gloria gives him her ideas in the form of a drawing or, as with the equalizer, a model. He and his staff then complete the design and put it into production. Gloria was encouraging the development of thinner and thinner radio and cassette mechanisms for the new year. She felt that the latest trends were leading in that direction, and she hoped that Toshiro and his staff could develop them in time for the new product year. At their Monday meeting they would discuss problems and progress of the new design.

After the conversation with Jim, Gloria continued on her way back to her office. "You'd never know how much work I have by looking at my desk," she thought as she sat down. The desk top was large but fairly empty. Between the "In" box on one side and a stack of trade journals on the other lay the bulletin she was working on. Everything else was put away. Gloria felt that you couldn't get ahead unless you were organized. And she was proud of her talent for organization.

Gloria glanced at her watch. It was 11:30, and she had an appointment for lunch at noon. With quick strokes of her pen she continued writing, changing a word here and adding a sentence there, until the bulletin was finished. Then, after checking the diagrams once more, she gave it to her secretary to be typed.



Gloria and Bob discuss plans for a new product. "A career in engineering has given me the opportunity to express myself creatively," says Gloria.

Exploring

Electrical engineers must deal with complex devices and understand how they work.

- Do you enjoy taking things apart to see how they work?
- Do you like to repair your bicycle?
- Do you fix your younger brothers' and sisters' toys?
- Are you good at repairing things around the house?
- Do you like to read about new inventions?

Electrical engineers apply what they know to solve practical problems.

- Do you like word problems in math?
- Do you like to solve engineering problems around the house, such as the best way of putting up a shelf?
- Do you wonder what relation your school subjects have to the real world?
- Are you more likely to study if you think a subject has practical value?

Electrical engineers deal with many ideas and objects that cannot be seen or felt. They must be able to think abstractly.

- Can you look at a pattern for a model or for clothing and picture the finished product?
- Can you look at a machine such as an automobile and picture its inner workings?

Electrical engineers look for creative answers to problems.

- Do you play games of strategy such as checkers, chess, or bridge?
- Do you enjoy solving puzzles?
- Do you like to think of new ways of doing things around the house?

Electrical engineers must pay attention to detail.

- Do you enjoy projects that involve precise, detailed handwork?
- Do you enjoy doing needlepoint? Painting by numbers? Building and rigging model ships? Building a radio from a kit?
- Do you go over your homework carefully before you hand it in?

Electrical engineers must continually read and learn, because new discoveries and inventions are made all the time.

- Do you like to read for pleasure?
- When you are curious about something, do you go to an encyclopedia or library to learn more about it?
- Do you like to read any popular scientific or technical magazines?
- Do you look up words you don't know in a dictionary?

Electrical engineers must be able to write clearly.

- Can you write street directions or other instructions?
- Can you write a recipe?
- Do you write your math or science homework clearly enough for others to follow it?

Electrical engineers must be able to discuss technical subjects.

- Can you express yourself well?
- If a teacher doesn't answer your question exactly, do you ask it again in a different way?
- Can you help your brothers, sisters, or friends with their homework?

Suggested Activities

Prepare a report on electric power in your community for your science or English class. Describe where and how the electricity you use is generated. Explain how it travels to your home. Explain how the quantity of electricity is measured and how much is used in your area. The community relations department of your local power company may have brochures and pamphlets that you can include in your report.

Arrange a class tour of a power station.

Prepare a report about electric current for your science class. Explain the difference between alternating and direct current (AC and DC). What kind of current is used in an automobile engine? A flashlight? Your home? How can you tell whether an electric line has AC or DC?

Learn about electricity on your own. Look for books on electricity in your school or public library. Some books outline simple experiments you can perform.

Experiment with electrical circuits. Hobby shops have kits that you can use to experiment with different kinds of simple circuits. Learn how to draw a diagram of a circuit. Find out what each symbol stands for.

Prepare a report for your science class about home appliances that use electricity. Which are electronic? What do the electronic appliances have in common? Explain why some appliance plugs have two prongs, while others have three. What is the purpose of the third prong?

Ask your parents to show you the fusebox or circuit breaker panel in your home. Find out why it is needed and what to do if a fuse or circuit breaker pops.

Build a crystal radio set. You can get help from books at your school or public library.

Become a ham radio operator. (Ham radios should not be confused with citizen's band, or CB, radios. With CB you can communicate only by voice and only over short distances. With a ham radio you use Morse code as well as voice, and you can broadcast all over the world.) To get your first license, you must demonstrate knowledge of radio concepts and the ability to understand Morse code at the rate of 5 words per minute. For full information, write to the American Radio Relay League, 225 Main Street, Newington, Ct. 06111.

Invite an electrical engineer to speak to your class about his or her job.

If you are a Boy Scout, try for merit badges in Electronics and Engineering.

If you are a Girl Scout, see if your local troop has the From Dreams to Reality program of career exploration. Troops also offer opportunities to test career interests through proficiency badges in a number of areas such as Science.

Join an Electronics or Engineering Explorer Post if there is one in your area. Exploring is open to young men and women aged 14 through 20. To find out about Explorer posts in your area, call "Boy Scouts of America" listed in your phone book, and ask for the "Exploring Division."

Enter a project on electronics in a science fair.

Visit a museum with your science class. Concentrate on the exhibits on electronics, computers, aviation, and space travel. Prepare questions for the museum guide on the contributions engineers have made in these areas.

To see if you can think abstractly, like an engineer, play mental tic-tac-toe. Picture the board in your mind, with each square numbered, one through nine. Play each turn by saying out loud the number of the square you want to mark. If one player forgets and names an occupied square, the other player wins. You'll have to concentrate to remember all the plays. It's harder than it sounds!

Write for the pamphlet on careers put out by the Educational Services Department, Institute of Electrical and Electronic Engineers, Inc., 345 East 47th Street, New York, New York 10017.

Related Occupations

Many kinds of engineers design, develop, and test products or systems. Electrical engineers are one kind. The names of ten others are listed below in jumbled form. See if you can figure out what they are. To help you, next to each name there are examples of the products or systems that the engineer works on.

1.	AIRMEN	Steam engines for ships.
2.	ANCHEMICAL	Air-conditioning systems.
3.	CANRULE	Atomic reactors.
4.	CAUREALATION	Airplanes and rockets.
5.	CEMICAR	Glass and tile.
6.	CIMLEACH	Rubber and plastics.
7.	ILVIC	Bridges, dams, and roads.
8.	PARTNATIONSORT	Streets and highways.
9.	TOOTUMIVEA	Car and truck motors.
10.	TOPICAL	Telescopes and cameras.

See answers at end of chapter.

Broadcast Technician

Technical school training in electronics led to a career in broadcasting for Edna Tower.

Edna Tower held up her right hand, palm forward, like a courtroom witness taking an oath. Punching a lighted button in front of her with her left hand, she heard the tape reels begin to spin. Then she closed her right fist and pointed her index finger forward. The woman on the right side of the double glass began reading in a crisp, pleasant voice from a page in front of her: "Looking for a truly professional dry cleaner? Then come to Top Notch Cleaners at six locations in Springfield ..." While the announcer's voice radiated from speakers in the control room, Edna watched the sound meter needles bounce and adjusted a slide control here and there. When the reading was finished, she punched another button to stop the tape. The women left the studio and Edna prepared for her next assignment.

Edna Tower works at radio station WELL as a production technician or engineer. WELL broadcasts classical music on AM and FM, and while located in a major city, the station employs a relatively small staff. This means that an experienced technician like Edna has many different kinds of duties each day. She enjoys this variety. Even though the big operations like rock 'n roll WAIL or news station WHAT could offer her more money, "they have you doing the same thing all day," explains Edna.

Edna had arrived at the station a bit before 9:30, had drunk a quick cup of coffee with one of the announcers, and was now in her control room.

Control room 3 is where Edna spends most of her time. She sits at a control board directly in front of the window facing the studio. The board has dozens of buttons, dials, meters, and slide switches that allow her to set sound levels in the studio, mix sounds from different sources (such as a speaking voice and background music), and operate the turntables and tape recorders in the room. From this board she can even control a live broadcast coming from outside the studio, such as a concert at the local symphony hall. Edna is particularly proud of this equipment, which she installed herself. At a larger station she might not have been given the opportunity. And she knows those buttons and switches by heart. "When you're in the middle of a performance, you can't take time to look at the board. You have to know where everything is by feel." The control room also contains three turntables for playing records, three reel-to-reel tape decks, two machines that play cartridge tapes (known as carts), plus devices for erasing used tape and cabinets containing tapes and tools.

Edna had begun this particular workday with the daily ritual of checking the equipment. First she had cleaned and "demagnetized" the "heads" on the tape decks (the small metal parts that touch the tape as it moves and actually create or erase the recording). Cleaning them requires only a wipe with a cotton swab dipped in alcohol, while a special electrical device, called a demagnetizer, is used to remove any unwanted magnetic interference that might make the recordings noisy. Next she had checked the machines overall to be sure they were running smoothly. (Once a week they would be tested more thoroughly, with electronic tools).

Shortly before 10, Renee Baily, the assistant programming director, had walked into the room with a pencil behind her ear and a clipboard in her hand. "There's a change of schedule," she had said. "The woman from the hospital came in early, so we'll tape her interview right away, then do the commercial spots, and do Lisa's program at 11."

Edna had glanced at the production schedule taped to the wall. The mimeographed sheet showed her workweek in half-hour slots and listed her assignments next to them. At 11 today she was scheduled to tape an interview with Emma Swenson, the special projects coordinator for the city's hospital for children. John Griffin, one of WELL's announcers, would conduct the interview. Since Mrs. Swenson had arrived early, they would do the interview immediately. Lisa Dillich's music appreciation program, which Edna was scheduled to record at 10, would be postponed.

Just then John walked in and introduced Mrs. Swenson. Edna then led them into the studio.

Much of what WELL's listeners hear on the air takes place in this 12- by 14-foot room called Studio 4. Inside the room one finds a carpet-covered table with several chairs, a grand piano, half a dozen large microphones on long stands, and an endless tangle of electrical cords on the floor. Mrs. Swenson commented on the large potted broadleafed palm standing in one corner of the room. "The music makes it grow very well," replied Edna.

John and his guest sat down at the table. After positioning a microphone, or "mike", between them, Edna returned to her control board and adjusted the volume level while the pair chatted. She threaded a reel of tape on one of the decks, reminded Mrs. Swenson to avoid rustling papers, and then signaled to John through the window that she was ready to go. Edna talks to people in the studio over the intercom, except when she is recording. Then, she signals by hand through the window. She held up her hand to ask for silence, started the tape, and pointed at John to tell him to begin. At the same moment she started a timer. "We have a 15-minute slot on Sunday," said Renee, watching over Edna's shoulder. "So let's take about 20 minutes' worth and cut it to size."

While John and his guest talked, Edna made a few minor sound adjustments. As the 20th minute approached, John wrapped up the interview. Edna anticipated his last words and stopped the tape just after he uttered them. "Great interview!" exclaimed Renee. "We'll air it Sunday." As Renee left the control room to say goodbye to Mrs. Swenson, Edna rewound the tape and returned it to its box. Later she and John would decide which parts to edit out.

Edna checked her watch. "It's 10:30. Tom should be here any minute to do these commercials." And as she was spinning a reel of tape on the bulk eraser to make it as clean as possible, Tom Nardone, another WELL announcer, walked into the studio with a sheaf of papers. He sat down at the table and adjusted the mike to his height. Edna threaded the tape and sat down at the board. "Read to me," she told Tom over the intercom, adjusting the volume. "We have half a dozen ads here," Tom finally said, "so it may take about 20 minutes." "Fine," answered Edna, and as she started the tape, she signaled Tom to begin.

Tom read each commercial in turn. Edna captured them all on reel tape; later she would transfer each ad to an individual cartridge. Then, during a broadcast, it would simply be popped into the cart machine and played at the right moment.

After putting away the tape she had just used, Edna went into the studio to set up the mikes for Lisa Dillich's program. Lisa had a weekly series of 1-hour shows in which she explained music concepts (such as key, chords, and harmony) in a way that the average listener could understand. She would play one or two pieces of music at the beginning, then talk about them, playing the piano to clarify her explanation. Lisa's programs were one reason Edna liked working at WELL. Though she had never thought much of classical music before, Edna grew to enjoy it as she heard more and more at the station. Listening to Lisa's series taught her something about the theory behind music.

Preparing for Lisa's show posed a new problem: Setting up the mikes to make both voice and piano sound good. While studying mechanical engineering in trade school, Edna learned about acoustics (the science of sound) and tone. So she knew that the studio, like any room, had certain acoustical characteristics. She had recommended that to improve sound quality, special panels be hung on the walls of the studio, some to reflect and some to absorb sound. Changing a room in this way is called "tuning" it. A studio used only for voice would be tuned differently than one used only for music. In this studio, which was used for both, a compromise had to be made. With her experience and technical knowledge, Edna was able to arrange the mikes to achieve a good sound.

Lisa came into the studio and sat down at the piano with her script. After a sound test on Lisa's voice and the piano, Edna signaled her to begin. Lisa read her script, illustrating with the piano where necessary. When she reached the place in the script where two complete musical selections would be played, she paused and then continued reading. Later Edna would take the music from records and mix it with Lisa's voice recording into a master tape.

The session with Lisa lasted until a quarter to 12. Forty-five minutes until lunch, with no other assignment. Just enough time to transfer those commercials to carts and insert the music in Lisa's show.

Edna's schedule after lunch, from 1:30 to 5:30, looked much like the morning—more recording and editing. But not every day was the same. Tomorrow she wouldn't have to arrive at the station until 1:30 p.m. From 6:30 to 9:30 she would operate the controls for WELL's nightly live program. The next day she would spend "in solitary confinement" at the transmitter.

The transmitter, located on a hill five miles from the

Edna is proud of the station's equipment, much of which she installed herself. "I have to keep checking it to make sure everything works right."

studios, is the source of WELL's signal, the invisible waves that travel to people's radios carrying music and voices. WELL has four 450-foot towers clustered around a small building. One person stays in the building the entire time the station is on the air, to make sure everything runs smoothly and according to Federal regulations. These tasks often require very little time, so the job can get lonely. But Edna rarely spends more than 2 or 3 days a month at the transmitter. And soon it will be operated by remote control from the studios.

The transmitter shift also gives Edna a chance to study for her evening classes in electronics. Although she attended technical school for 2 years after high school to get the necessary First Class Radiotelephone Operator's License, she wants to increase her knowledge of electronics, in order to keep up with new developments and to remain competitive in her occupation. The community college offers a degree in electronics, and Edna hopes to have hers next term.

Generally, Edna Tower is satisfied with her job. She uses knowledge of electronics, acoustics, and music. She installs and repairs the equipment as well as operates it. She does many different things. And she does them all with pride. Anything it takes to improve WELL's sound quality, she's willing to do. Her only complaint is that WELL's listeners don't know about her work. "The better job a technician does, the less it's noticed. I'm behind the scenes—the audience may not even know about my part in presenting a show."

Exploring

Technicians must train their ears to pick out imperfections in the recordings they make and in the broadcasts they engineer.

- Do you like to listen closely to music and pick out its different parts?
- Can you tell a good recording from a poor one?
- When listening to the radio, do you adjust the tuning to get the best sound from the station?

Technicians often have odd work schedules.

- Would you mind working nights, early mornings, or weekends?
- Could you adjust to having different working hours each day of the week?

Technicians often must operate controls continually through long broadcasts.

- Can you sit still and pay attention to something for a long period of time?
- Can you be patient during classes that don't really interest you?
- Do you play long games such as Monopoly?
- Do you watch TV programs that run 2 hours or more?

Technicians usually spend most of their workday in a few small studio rooms.

- Would you be satisfied working inside all day long?
- Would it bother you to spend the day in a small room with no outside windows?

Technicians often are given new tasks before they finish their current ones.

- Are you able to handle several projects or homework assignments at the same time?
- Can you finish them all on time?
- Is it easy for you to switch back and forth from one project to another?

Technicians must think and act quickly if something unexpected happens during a broadcast.

- Can you stay calm and act sensibly if a toilet overflows, the lights go out, the roof leaks, or some other emergency occurs at home?
- Do you know whom to call if something goes wrong when your parents are away?
- Are you good at handling crises on the school grounds or playground?

Technicians must keep an eye on several things at once.

- Can you cook a whole meal yourself and have everything ready at the same time?
- Do you enjoy watching sports such as football, basketball, soccer, or hockey in which you have to keep track of many players at once?
- Do you play complex games like chess or bridge?

Technicians work with their hands.

- Do you have any hobbies or crafts that require fine handwork?
- Are you good with tools?
- Do you play a musical instrument?

Suggested Activities

Arrange a tour of a radio or TV station for yourself or your class. Prepare questions for the employees about their work.

Listen to the radio. Pick out the recorded voices (such as repeated commercials and jingles) from the live voices (disc jockeys and news announcers). Try to imagine how the recordings were made and how they are played during the program. This activity may be easier after doing the preceding one.

Listen to AM radio at two different times of day, once during daylight (say, 4 p.m.) and once after dark (say, 9 p.m.). Each time pick a dozen or so stations, listing

As a radio station technician, Edna works strictly behind the scenes. "My job is to see that our listeners get good quality sound."

the call letters (such as WDAD or KMOM), location, and, if possible, frequency (number on the dial) of each. Do you notice a difference between the two lists? The stations on the daytime list are likely to be broadcasting from a much shorter distance away than those on the night list. Investigate the reason for this.

Build a crystal radio set. You can get help from books at your school or public library.

Become a ham radio operator. (Ham radios should not be confused with citizen's band, or CB, radios. With CB you can communicate only by voice and only over short distances. With a ham radio you use Morse code as well as voice, and you can broadcast all over the world.) To get your first license, you must demonstrate knowledge of radio concepts and the ability to understand Morse code at the rate of 5 words per minute. For full information, write to the American Radio Relay League, 225 Main Street, Newington, Ct. 06111.

Prepare a report for your science class. Answer the following questions in your report: What do AM and FM stand for? What is the difference between the two? What are the advantages of each? How and when did each come into existence? What are some of the other bands, and how are they used? Include in your report a diagram and an explanation of how sounds travel from a source to the listener's radio.

If you are a Girl Scout, see if your local troop has the From Dreams to Reality program of career exploration. Troops may also offer opportunities to test career interests through proficiency badges in a number of areas including Radio and Television.

If you are a Boy Scout, try for merit badges in Communications, Electronics, Public Speaking, and Radio.

Join a Broadcasting, Electronics, Amateur Radio, or Communications Explorer Post if there is one in your area. Exploring is open to young men and women aged 14 through 20. To find out about Explorer posts in your area, call "Boy Scouts of America" listed in your phone book, and ask for the "Exploring Division."

Write for information on careers to the National Association of Broadcasters, 1771 N Street, N.W., Washington, D.C. 20036 or to the Corporation for Public Broadcasting, 1111 16th Street, N.W., Washington, D.C. 20036. For information on the Radiotelephone Operator's License, write to the Consumer Assistance Office, Federal Communications Commission, 1919 M Street, N.W., Washington, D.C. 20554. For information on technical careers, write to Technical Careers, Box 111, Washington, D.C. 20044.

Related Occupations

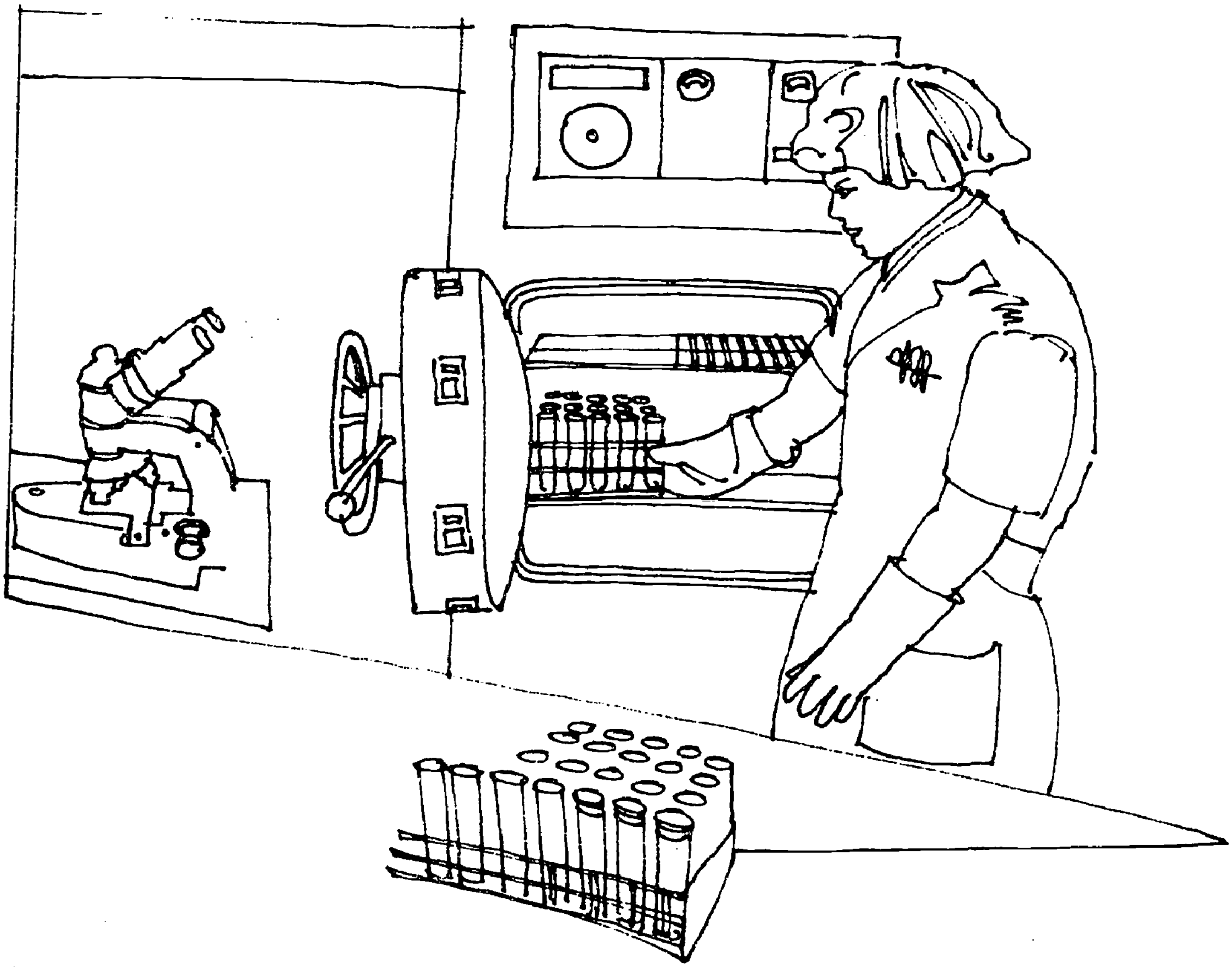
Does a career as a broadcast technician interest you? "Yes and no," you may say. Or, "I'm not sure." You might find it worth looking into other occupations that are similar to broadcast technician.

If you like the idea of working in radio but don't want such a technical job, picture yourself behind the microphone. As a *radio announcer* or *disc jockey*, you would talk to the listening audience. Your work might include announcing and playing records; reading commercial and public service messages; and doing news broadcasts and interviews.

Or maybe you'd rather work in television. As a *TV production technician*, you would engineer a TV broadcast much the way Edna engineered a radio program. You might also enjoy capturing the action as a *video camera operator*.

You may not have thought about it, but the music industry employs technicians, too. As a *recording engineer*, you would set up microphones in a studio and operate the sound equipment while a singer or an orchestra made a recording. The recording is made in several different parts, or tracks. As a *recording mixer*, you would adjust the tracks and blend them together in the way that would sound best on the finished record.

Job Facts



There isn't room in this book for a story about every scientific and technical occupation. However, you'll find some important facts about 28 of them in the following section. If you want additional information about any of these occupations, you might begin by consulting the Department of Labor's *Occupational Outlook Handbook*, which should be available in your school or public library.

Occupation	*Nature and Places of Work*	*Training and Qualifications*	*Other Information*
LIFE SCIENCE OCCUPATIONS			
Biochemists	About half of all biochemists work for colleges and universities, while a fourth work for private companies. The rest work for government agencies, private research institutes, or for themselves.	A graduate degree is necessary. A bachelor's degree in biochemistry or chemistry may lead to a job as a research assistant or technician. People with jobs as biochemists, especially in research or teaching, generally have a graduate degree in biochemistry.	The great majority of biochemists hold research positions, rather than managerial or other positions.

Scientific and Technical Occupations

Occupation	*Nature and Places of Work*	*Training and Qualifications*	*Other Information*
Life Scientists	Most life scientists work for colleges and universities as teachers and researchers. Many do research in hospitals and other medical institutions. The drug, chemical, and food processing industries employ large numbers of life scientists, as do Federal. State. and local government agencies.	A bachelor's degree in biology may lead to a job as a research assistant or technician; a career as a life scientist. however, generally requires a graduate degree.	Life scientists specialize in a wide variety of subjects. They may concentrate on either plants or animals, or even study just one kind of plant or animal. Some study breeding while others investigate diseases. Still others examine drugs and their effects on living things. Life scientists perform many different kinds of work, from research and teaching to advising, managing, and writing.
PHYSICAL SCIENTISTS			
Astronomers	Most astronomers teach and do research in colleges and universities. Many others work for the Federal Government and for private observatories.	A doctoral degree in astronomy is necessary for most jobs. To qualify for a graduate program in astronomy, a student should have a bachelor's degree in astronomy, physics, or math.	The majority of astronomers spend most of their time working in offices or classrooms, rather than at telescopes.
Chemists	About three-fourths of all chemists work in private industry. Chemical manufacturers employ almost half of these, and the rest work for food, scientific instrument, petroleum, and other industries. Quite a few chemists work for colleges and universities.	A college education is necessary. Beginning jobs are open to people with a bachelor's degree in chemistry, but a graduate degree is necessary for some research and teaching positions, and is useful for advancement.	Most chemists perform basic research or research and development. In basic research, a chemist explores the properties of matter and the combination of elements. A chemist in research and development creates or improves products for direct use.
Food Scientists	Food scientists work all over the country for companies in the food processing industry as well as for Federal and State agencies, colleges and universities. and other organizations.	A college education is necessary. A bachelor's degree in food science, biology, or chemistry is the minimum requirement for beginning positions. Many jobs, especially teaching and research. require a graduate degree.	Many food scientists work in research and development of new food products and processing techniques.
Physicists	Nearly half of all physicists teach or perform research at colleges and universities. Many others work in chemical. electrical equipment, aircraft and missile. and other manufacturing companies.	Graduate study in physics is essential for most beginning positions and for all advanced ones.	Physicists usually specialize in a particular area, such as nuclear physics, optics, or acoustics.
ENVIRONMENTAL SCIENTISTS			
Geologists	Most geologists work in private industry. for petroleum, mining, quarrying. and other companies. Many work for Federal and State agencies and colleges and universities.	A college education is necessary in this occupation. While a bachelor's degree is enough for some starting jobs. a graduate degree is helpful for promotion.	Geologists may work outdoors much of the time, depending upon their specialty. They often work in offices and laboratories, however.

Occupation	*Nature and Places of Work*	*Training and Qualifications*	*Other Information*
Geophysicists	Most geophysicists work in private industry, for petroleum, natural gas, mining, and other companies. Most of the others are employed by Federal and State government agencies or by colleges and universities.	A college education is necessary in this occupation. A bachelor's degree in geophysics is sufficient for most beginning jobs. A degree in a related field is also adequate, as long as the student has taken certain courses. For higher positions in research, exploration, and teaching, a graduate degree is desirable.	Many geophysicists work outdoors and travel extensively. Some work at research stations in remote areas or on ships or aircraft.
Meteorologists	The National Oceanic and Atmospheric Administration, private industry, and colleges and universities all employ meteorologists. The Department of Defense employs civilian meteorologists in addition to those in the military services.	A college degree is necessary. A bachelor's degree in meteorology or a related science is the minimum requirement for starting jobs. A graduate degree is important for promotion, and essential for research and college teaching jobs.	Not all meteorologists forecast the daily weather. Some work in climatology, the study of long-term weather trends; others administer programs or teach.
Oceanographers	About half of all oceanographers teach or do research at colleges and universities. A fourth work for Federal agencies. The rest work for other government agencies and for private industry.	A college education is necessary. Most beginning positions require a bachelor's degree in oceanography, biology, earth or physical sciences, mathematics, or engineering. For many advanced positions, however, an advanced degree in oceanography or a basic science is desirable.	Some oceanographers are away from home for weeks or months at a time while on ocean research voyages.
MATHEMATICS OCCUPATIONS			
Mathematicians	About three-fourths of all mathematicians work in colleges and universities, the majority of them as teachers. Most others are employed in government and private industry.	A graduate degree usually is necessary. While a bachelor's degree may lead to a beginning job, promotional opportunities are limited without graduate study. A person seeking work as an applied mathematician in a field such as physics or economics needs training in that field as well as in mathematics.	Mathematicians can work in theoretical (pure) or applied mathematics. Theoretical mathematicians develop new mathematical techniques and knowledge without necessarily having a practical use in mind. Applied mathematicians use that knowledge to solve everyday problems in physics, engineering, business, economics, and other fields.
Statisticians	Most statisticians work for insurance firms, finance companies, public utilities, manufacturers, and research organizations. Many others work for Federal, State, and local government agencies.	A college education is necessary. Most beginning positions require a bachelor's degree either with a major in math or statistics or with a major in an applied field, such as economics, and a minor in statistics. Graduate training is necessary for teaching positions and helpful for promotion in other areas.	Because the science of statistics is used so widely in other fields, statisticians often work under other titles. A statistician working with information on the economy, for example, may have the title of economist.

Scientific and Technical Occupations

Occupation	Nature and Places of Work	Training and Qualifications	Other Information
ENGINEERS			
Aerospace Engineers	Most aerospace engineers work for the aircraft and parts industry. Many others are employed by the National Aeronautics and Space Administration and by the Department of Defense.	A bachelor's degree in engineering is required for most beginning jobs. Some engineering jobs are filled by people trained in the appropriate natural science or in mathematics. Graduate study is increasingly important for advancement.	Aerospace engineers often specialize in one area, such as structural design, navigation systems, or production methods. They may also specialize in a particular product line, such as passenger planes, helicopters, or satellites.
Agricultural Engineers	Most agricultural engineers work for manufacturers and distributors of farm equipment and supplies or for electric utility companies serving rural areas. Many do farm consulting work independently or for consulting firms. Others work for the U.S. Department of Agriculture, for colleges and universities, and for State and local government agencies.	A bachelor's degree in engineering is required for most beginning jobs. Some engineering jobs are filled by people trained in the appropriate natural science or in mathematics. Graduate study is increasingly important for advancement.	The work of agricultural engineers covers many different aspects of agriculture: Conserving and managing soil and water resources, designing farm equipment, and improving techniques for producing, processing, and distributing food.
Biomedical Engineers	Most biomedical engineers teach and do research in colleges and universities. Some work for Federal and State agencies or for private industry.	A bachelor's degree in engineering is required for most beginning jobs. Some engineering jobs are filled by people trained in the appropriate natural science or in mathematics. Graduate study is increasingly important for advancement. Biomedical engineers need some background in mechanical, electrical, industrial, or chemical engineering, as well as specialized biomedical training.	The small size of this occupation means that there are relatively few job openings each year.
Ceramic Engineers	Most ceramic engineers work in the stone, clay, and glass industries. Many others work in the iron and steel, electrical equipment, aerospace, chemical, and other industries that produce or use ceramic products.	A bachelor's degree in engineering is required for most beginning jobs. Some engineering jobs are filled by people trained in the appropriate natural science or in mathematics. Graduate study is increasingly important for advancement.	Ceramic engineers generally specialize in particular products, such as heat-resistant material, porcelain, building material, glass, or cement.
Chemical Engineers	Most chemical engineers work for chemical, petroleum, and related manufacturers. Others are employed by colleges and universities and by government agencies.	A bachelor's degree in chemical engineering is required for most beginning jobs. Graduate study is increasingly important for advancement.	Chemical engineering is a broad field with many specialties.

Occupation	*Nature and Places of Work*	*Training and Qualifications*	*Other Information*
Civil Engineers	Most civil engineers work for government agencies or in the construction industry. Others provide engineering advice for consulting or architectural firms. Still others work for public utilities, railroads, and manufacturers.	A bachelor's degree in engineering is required for most beginning jobs. Some engineering jobs are filled by people trained in the appropriate natural science or in mathematics. Graduate study is increasingly important for advancement.	Civil engineers may specialize in such areas as structural, hydraulic, sanitary, and transportation systems.
Electrical Engineers	Electrical engineers are employed in private industry by manufacturers of many different products, particularly electrical and electronic equipment, aircraft and parts, and business machines. Others work for public utilities, government agencies, and colleges and universities.	A bachelor's degree in engineering is required for most beginning jobs. Some engineering jobs are filled by people trained in the appropriate natural science or in mathematics. Graduate study is increasingly important for advancement.	Electrical engineers generally specialize in a major area such as computers, communications, integrated circuits, or power distribution.
Industrial Engineers	Industrial engineers are employed by a greater variety of industries than any other type of engineer. Most work for manufacturing firms, but many work for hospitals, insurance companies, banks, and consulting firms.	A bachelor's degree in engineering is required for most beginning jobs. Some engineering jobs are filled by people trained in the appropriate natural science or in mathematics. Graduate study is increasingly important for advancement.	Industrial engineers concern themselves more with people, organizations, and business methods than do other kinds of engineers.
Mechanical Engineers	Most mechanical engineers are employed by manufacturers of metals, machinery, transportation and electrical equipment, and other products.	A bachelor's degree in engineering is required for most beginning jobs. Some engineering jobs are filled by people trained in the appropriate natural science or in mathematics. Graduate study is increasingly important for advancement.	Mechanical engineers specialize in such areas as automotive engineering, marine equipment, heating and air-conditioning, and instrumentation.
Metallurgical Engineers	Most metallurgical engineers are employed by the iron and steel and other metalworking industries. Many work in the mining industry or for firms that manufacture electrical equipment, machinery, and aircraft.	A bachelor's degree in engineering is required for most beginning jobs. Some engineering jobs are filled by people trained in the appropriate natural science or in mathematics. Graduate study is increasingly important for advancement.	Most metallurgical engineers specialize in one of three areas: Extracting metals from ore and refining them; studying the properties of metals and developing uses for them; and working and shaping metals into final products.
Mining Engineers	Most mining engineers are employed in the mining industry. Others work for mining equipment manufacturers, colleges and universities, and government.	A bachelor's degree in engineering is required for most beginning jobs. Some engineering jobs are filled by people trained in the appropriate natural science or in mathematics. Graduate study is increasingly important for advancement.	Mining engineers often specialize in the mining of a specific mineral, such as coal.

Scientific and Technical Occupations

Occupation	Nature and Places of Work	Training and Qualifications	Other Information
Petroleum Engineers	Most petroleum engineers are employed by oil companies and by drilling equipment manufacturers. Almost three-fourths work in Texas, Oklahoma, Louisiana, and California, where most of the oil and gas is found.	A bachelor's degree in engineering is required for most beginning jobs. Some engineering jobs are filled by people trained in the appropriate natural science or in mathematics. Graduate study is increasingly important for advancement.	Most petroleum engineers concern themselves with ways of increasing the amount of oil and gas that can be removed from the ground.
TECHNICIANS			
Broadcast Technicians	Broadcast technicians are employed by radio and television stations. Most technicians work in large metropolitan areas.	A First Class Radiotelephone Operator License from the Federal Communications Commission (FCC) is required for most positions. For some jobs, a Third Class License is sufficient. High school courses in algebra, trigonometry, physics, electronics, and other sciences provide good background for this occupation.	A technician's range of duties depends upon the size of the station. Large stations may assign each technician a specific duty, while at small stations a technician may perform any task necessary.
Drafters	Most drafters work in private industry. Almost one-third of these work in engineering and architectural firms. The government also employs many drafters.	Most positions require training in drafting such as is available at technical institutes, junior and community colleges, university extension services, and vocational and technical high schools. Courses in math, physical sciences, mechanical drawing, and drafting are important.	Drafters usually specialize in a particular area, such as mechanical, electrical, electronic, aeronautical, or architectural drafting.
Engineering and Science Technicians	Most technicians are employed in private industry, though a large number work in government.	Most positions require technical training in a particular specialty. This is available through technical institutes, junior and community colleges, university extension services, and vocational-technical high schools. On-the-job experience, apprenticeship programs, and correspondence schools may also provide the necessary training.	More than two-thirds of all technicians work in engineering. Many work in the physical sciences, and the rest work in the life sciences.
Surveyors	The government employs many surveyors. Other employers include construction companies, engineering and architectural firms, and surveying companies.	Post-high school courses in surveying combined with extensive on-the-job training provide enough background for many positions. A degree in surveying from a junior or community college, technical institute, or vocational school is also sufficient. High school courses in mathematics, drafting, and mechanical drawing are helpful.	Surveyors often specialize in surveys for highways, real estate boundaries, maps, or other purposes.

Answers to Related Occupations

BIOCHEMIST

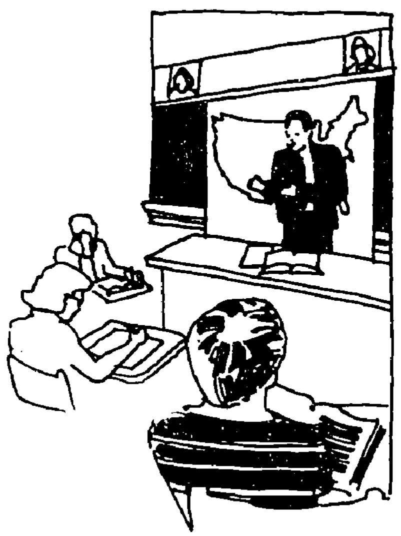
1. a, 2. c, 3. a, 4. b, 5. b, 6. c, 7. a.

ELECTRICAL ENGINEER

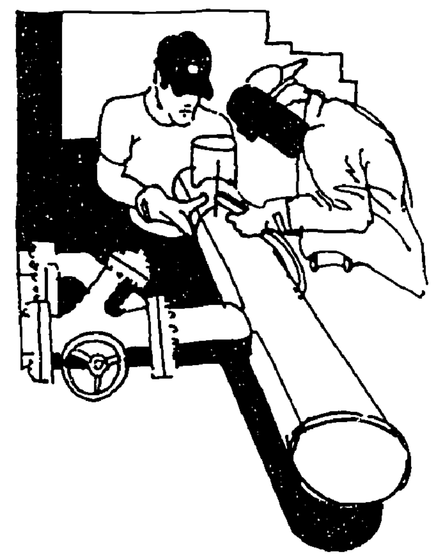
1. Marine, 2. Mechanical, 3. Nuclear, 4. Aeronautical, 5. Ceramic, 6. Chemical, 7. Civil, 8. Transportation, 9. Automotive, 10. Optical.

Occupational Outlook Handbook

One of the most widely used resources in the field of vocational guidance, the Handbook is an "encyclopedia of careers" covering several hundred occupations. A new edition is published every 2 years. The reader will find information on



- What the work is like
- Job prospects
- Personal qualifications
- Education and training requirements
- Earnings
- Related occupations
- Where to find additional information.

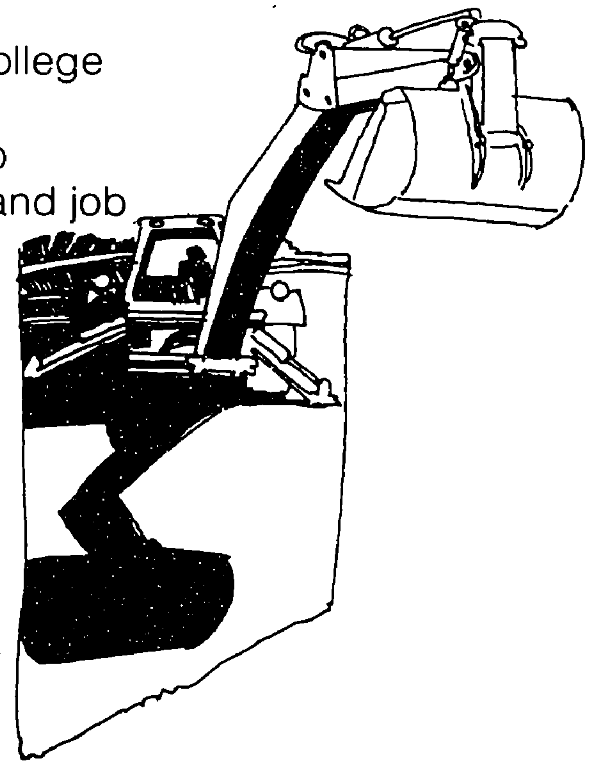


Contact any of the BLS Regional Offices listed inside the back cover for price and ordering information.

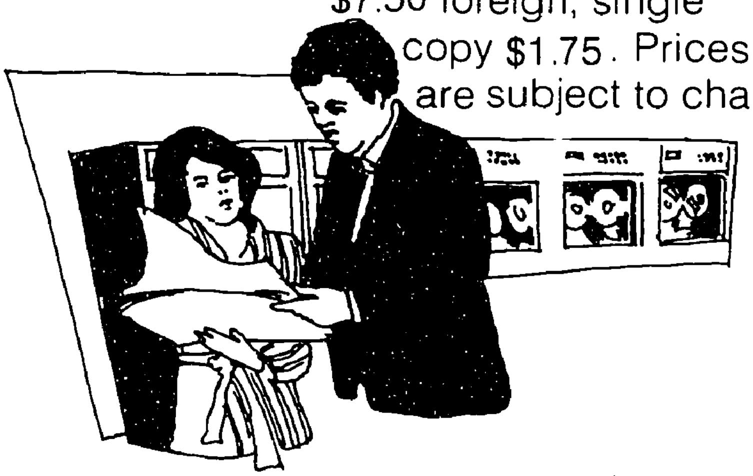
Occupational Outlook Quarterly

A periodical to help students, job seekers, counselors, and education planners keep up with occupational and employment developments. The Quarterly is written in nontechnical language and illustrated in color. Articles cover such topics as these:

- Job prospects for college graduates
- How to look for a job
- Matching personal and job characteristics

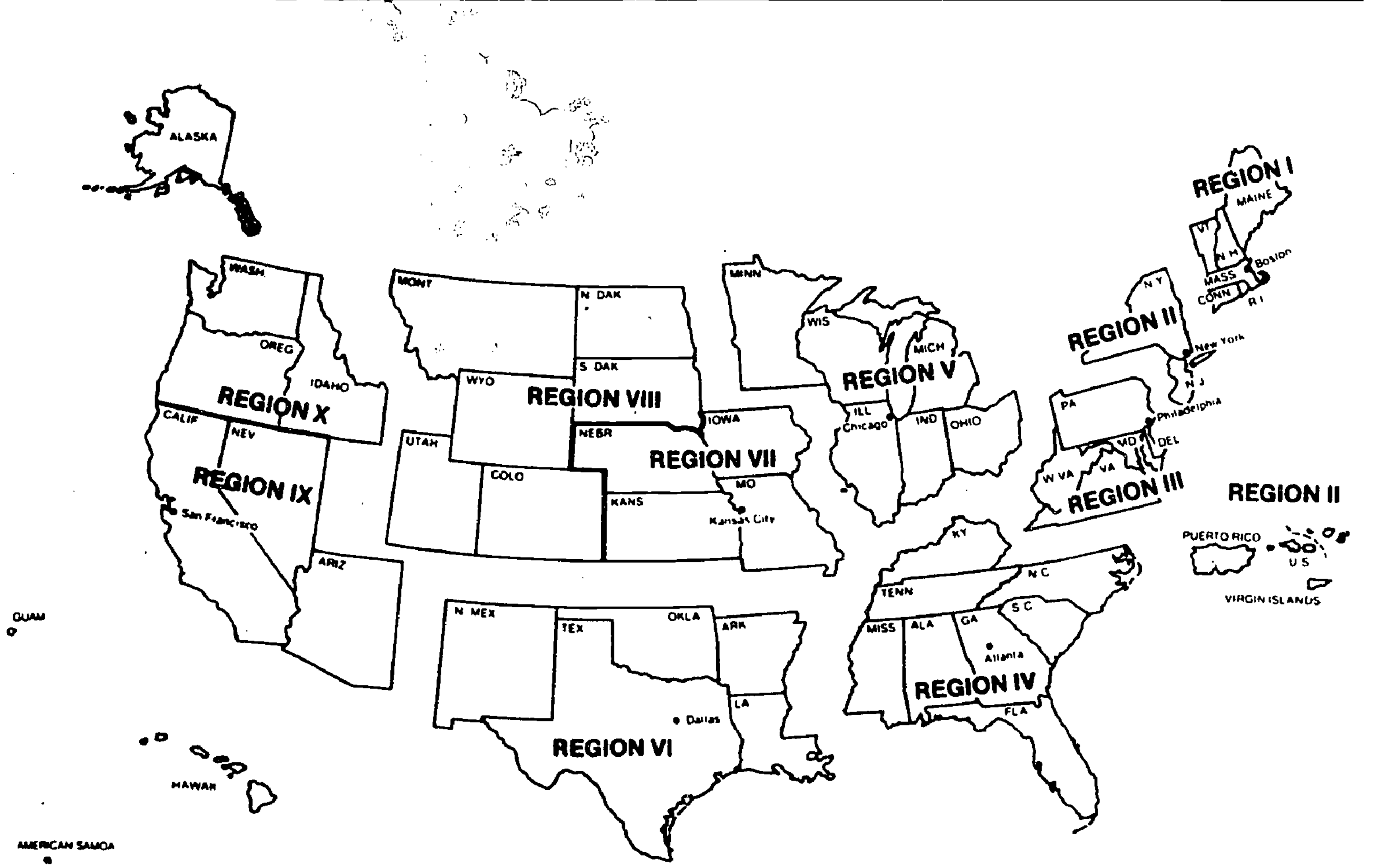


For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Subscription price per year (4 issues) is $6 domestic, $7.50 foreign, single copy $1.75. Prices are subject to change.



☆ U.S. GOVERNMENT PRINTING OFFICE : 1980 O - 326-029 : QL 3

Bureau of Labor Statistics Regional Offices



Region I
1603 JFK Federal Building
Government Center
Boston, Mass. 02203
Phone: (617) 223-6761

Region II
Suite 3400
1515 Broadway
New York, N.Y. 10036
Phone: (212) 944-3121

Region III
3535 Market Street
P.O. Box 13309
Philadelphia, Pa. 19101
Phone: (215) 596-1154

Region IV
1371 Peachtree Street, N.E.
Atlanta, Ga. 30309
Phone: (404) 881-4418

Region V
9th Floor
Federal Office Building
230 S. Dearborn Street
Chicago, Ill. 60604
Phone: (312) 353-1880

Region VI
Second Floor
555 Griffin Square Building
Dallas, Tex. 75202
Phone: (214) 767-6971

Regions VII and VIII
911 Walnut Street
Kansas City, Mo. 64106
Phone: (816) 374-2481

Regions IX and X
450 Golden Gate Avenue
Box 36017
San Francisco, Calif. 94102
Phone: (415) 556-4678