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ABSTRACT

This document provides information about careers in the agricultural sciences, the biological sciences, chemistry, forestry and conservation, geology and geophysics, meteorology, and physics. The information, presented in separate sections for each of these disciplines, includes: (1) nature of the work performed by scientists in the discipline(s); (2) working conditions; (3) employment; (4) training, other qualifications, and advancement opportunities; (5) job outlook; (6) earnings; (7) related occupations; and (8) sources of additional information. (JN)

Agricultural Scientists

(D.O.T. 040.061-010, -014, -018, -038, -042, and -058; 041.061-014, -018, and -082)

Nature of the Work

The work done by agricultural scientists has played an important part in making American farm workers the most productive agricultural workers in the world. Agricultural scientists study farm crops and animals and develop ways of improving their quantity and quality. They look for ways to increase yields with less labor, control pests and weeds more effectively, and conserve soil and water. Agricultural science is closely related to biological science in that both involve the study of living organisms; agricultural scientists then apply this knowledge to solving practical problems in agriculture.

About 40 percent of all agricultural scientists manage or administer research and development projects or marketing or production operations in companies that produce agricultural chemicals or machinery. About 20 percent do research and development. Some spend most of their time in laboratories, but some in research and development spend much of their time working with plants and animals in the field. Some agricultural scientists teach in colleges and universities and others work as consultants to business firms or to government.

Agricultural scientists usually specialize in one of the following areas. *Agronomists* (D.O.T. 040.061-010) are concerned with the growth and improvement of field crops. They improve the quality and yield of crops such as corn, wheat, and cotton by developing new growth methods or by controlling diseases, pests, and weeds. Some agronomists may specialize in a particular crop or crop problem.

Animal scientists (D.O.T. 040.061-014) do research on the breeding, feeding, and diseases of domestic farm animals.

Dairy scientists (D.O.T. 040.061-018) and *Poultry scientists* (D.O.T. 040.061-042) conduct research on the breeding, feeding, and management of dairy cattle and poultry.

Horticulturists (D.O.T. 040.061-038) work with orchard and garden plants such as fruit and nut trees, vegetables, and flowers. They seek to improve plant culture methods for the beautification of communities, homes, parks, and other areas as well as for increasing crop quality and yields.

Soil scientists (D.O.T. 040.061-058) study soil characteristics, map soil types, and determine the best types of crops for each soil. They study the responses of various types of soils to fertilizers, tillage practices, crop rotation, and other actions which affect the soil.

Animal breeders (D.O.T. 041.061-014) and *plant breeders* (D.O.T. 041.061-082) develop systems of breeding to develop and improve desirable characteristics of animals and plants.

Apiculturists (D.O.T. 041.061-018) study the culture and breeding of bees.

Working Conditions

Agricultural scientists generally work regular hours in offices, laboratories, or classrooms. Some agricultural scientists spend much time outdoors conducting research on farms or agricultural research stations.

Employment

Agricultural scientists held about 22,000 jobs in 1982. In addition, over 15,000 persons held agricultural science faculty positions in colleges and universities in 1982. (See the statement on college and university faculty elsewhere in the *Handbook*.)

Almost half of all agricultural scientists work for Federal, State, or local governments. Almost 3,000 worked for the Federal Government in 1982, mostly in the Department of Agriculture. Large numbers worked for State governments at State agricultural colleges or agricultural research stations. Almost 10 percent of all agricultural scientists work for agricultural service companies; others work for fertilizer companies, seed companies, and wholesale distribution companies. Over 2,000 agricultural scientists were self-employed in 1982, mainly as consultants.

Training, Other Qualifications, and Advancement

Training requirements for agricultural scientists depend on the specialty and the type of work performed. A Ph.D. degree in an agricultural science specialty is usually required for college teaching, independent research, and for advancement to many administrative and management jobs. A master's degree is sufficient for some jobs in applied research. The bachelor's degree is adequate preparation for some jobs in sales, inspection, and other nonresearch areas, but, in some cases, promotions may be limited for those who hold no higher degree. Those who hold degrees in related sciences such as biology, chemistry, or physics also may enter some agricultural science jobs.

All States have at least one land-grant college which offers agricultural science curriculums. Many other colleges and universities also offer some kind of agricultural science courses. Since some schools may not offer all specialties, students should investigate carefully the course offerings of the schools they are considering. Requirements for advanced degrees usually include fieldwork and laboratory research as well as classroom studies and preparation of a thesis based on independent research.

Agricultural scientists should be able to work independently or as part of a team and must be able to communicate their findings clearly and concisely, both orally and in writing.

Agricultural scientists who have advanced degrees usually begin in research or teaching jobs. With experience, they may advance to jobs such as supervisors of research programs.

Job Outlook

Employment of agricultural scientists is expected to grow more slowly than the average for

Agricultural scientists examine a newly developed variety of orghum.

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all occupations through the mid-1990's. Many agricultural scientists work for Federal, State, or local governments where little employment growth is expected. Employment of agricultural scientists involved in research may grow rapidly in private industry as advances such as recombinant DNA now being made in biotechnology are applied to agriculture. In addition to jobs arising from growth in demand for agricultural scientists, job openings will occur as agricultural scientists transfer to other occupations, retire, or die.

Employment opportunities in agricultural science are expected to be better for those with advanced degrees. However, a bachelor's degree in agricultural science is useful for occupations such as farmer or farm manager, cooperative extension service worker, technician, or seed or fertilizer company sales representative. Persons with degrees in agricultural science also work for businesses that deal with farmers such as banks and farm equipment manufacturers.

Earnings

According to the College Placement Council, beginning salary offers for agricultural scientists with the bachelor's degree averaged $16,700 a year in 1982.

In the Federal Government in early 1983, agricultural scientists with a bachelor's degree could start at $13,369 or $16,559 a year, depending on their college records. Those having the master's degree could start at $16,559 or $20,256, depending on their academic records or work experience; and those having the Ph.D. degree could begin at $24,508 or $29,374 a year. Agricultural scientists in the Federal Government averaged about $28,000 a year in 1982.

Related Occupations

The work of agricultural scientists is closely related to that of biologists as well as to other natural scientists such as chemists and physicists. It is also related to agricultural production occupations such as farmer and farm manager and to cooperative extension service workers as well as to foresters and conservation scientists. Certain specialties of agricultural science are also related to other occupations. For example, animal scientists are related to veterinarians, horticulturists to landscape architects, and soil scientists to soil conservationists.

Source of Additional Information

Information on careers in agricultural science is available from:

Higher Education Programs, Agricultural Research Service, U.S. Department of Agriculture, Administration Building, 14th St. and Independence Ave. SW., Washington, D.C. 20250.

American Society of Agronomy, 677 S. Segoe Rd., Madison, Wis. 53711.

Crop Science Society of America, 677 S. Segoe Rd., Madison, Wis. 53711.

Soil Science Society of America, 677 S. Segoe Rd., Madison, Wis. 53711.

For information on careers in horticultural science, send a stamped, self-addressed envelope to:

American Society for Horticultural Science, 701 North Saint Asaph St., Alexandria, Va. 22314.

Information on Federal job opportunities is available from local offices of State employment services and the U.S. Office of Personnel Management or from Federal Job Information Centers located in various large cities throughout the country.

Biological Scientists

(D.O.T. 041.061, except 014, 018, 026, 034, 054, 070, 074, 082, and 090; and 167.010)

Nature of the Work

Biological scientists study all aspects of living organisms and the relationship of animals and plants to their environment. Although many specialize in some area such as ornithology (the study of birds) or microbiology (the study of microscopic organisms), all have in common the study of life.

Many biological scientists are primarily involved in research and development. Some conduct basic research to increase knowledge of living organisms. Others in applied research use this knowledge in activities such as developing new medicines, increasing crop yields, and improving the environment. Those working in laboratories must be familiar with research techniques and the use of laboratory equipment and computers. Not all research, however, is performed in laboratories. For example, a botanist may do research in the volcanic valleys of Alaska to see what plants grow there.

Other biological scientists work in management or administration, for example planning and administering programs for testing foods and drugs and directing activities at zoos or botanical gardens. Some work as consultants to business firms or to government, while others test and inspect foods, drugs, and other products or write for technical publications. (See the statement on technical writers elsewhere in the *Handbook*.) Some work in technical sales and service jobs for companies manufacturing chemicals or other technical products. (See the statements on manufacturers' sales representatives and wholesale trade sales workers elsewhere in the *Handbook*.)

Most biological scientists who come under the broad category of *biologist* (D.O.T. 041.061-030) are further classified by the type of organism they study or by the specific activity they perform.

Anatomists (D.O.T. 041.061-010) study and examine the structure of organisms, from cell structure to the formation of tissues and organs. Many specialize in human anatomy. Research methods may entail dissections or the use of electron microscopes.

Botanists (D.O.T. 041.061-038) deal primarily with plants and their environment. Some study all aspects of plant life, while others specialize in areas such as identification and

Biological scientists study living organisms and life processes.

classification of plants, the structure and function of various plant parts, and the causes and cures of plant diseases.

Embryologists study the development of an animal from a fertilized egg through the hatching process or birth, and the causes of healthy and abnormal development.

Microbiologists (D.O.T. 041.061-058) investigate the growth and characteristics of microscopic organisms such as bacteria, viruses, and molds. *Medical microbiologists* study the relationship between bacteria and disease or the effect of antibiotics on bacteria. Other microbiologists specialize in soil bacteriology (the effect of microorganisms on soil fertility), virology (viruses), or immunology (mechanisms that fight infections).

Pharmacologists (D.O.T. 041.061-074) and *toxicologists* conduct tests on animals such as rats, guinea pigs, and monkeys to determine the effects of drugs, gases, poisons, dusts, and other substances on the functioning of tissues and organs. Pharmacologists may develop new or improved drugs and medicines.

Physiologists (D.O.T. 041.061-078) study life functions of plants and animals under normal and abnormal conditions. Physiologists may specialize in functions such as growth, reproduction, photosynthesis, respiration, or movement, or in the physiology of a certain area or system of the body.

Zoologists (D.O.T. 041.061-090) study various aspects of animals—their origin, behavior, diseases, and life processes. Some experiment with live animals in controlled or natural surroundings while others dissect dead animals to study their structure. Zoologists are usually identified by the animal group studied—ornithologists (birds), entomologists (insects), mammalogists (mammals), herpetologists (reptiles), and ichthyologists (fish).

Some biological scientists apply their knowledge across a number of areas and may be classified by the functions performed. *Ecologists*, for example, study the relationship between organisms and their environments and the effects of influences such as pollutants.

rainfall, temperature, and altitude on organisms. For example, ecologists examine plankton (microscopic water plants and animals) and measure the radioactive content of fish to determine the effects of pollution.

Agricultural scientists, who may also be classified as biological scientists, are included in a separate statement elsewhere in the *Handbook*.

Working Conditions

Biological scientists generally work regular hours in offices, laboratories, or classrooms and usually are not exposed to unsafe or unhealthy conditions. Some biological scientists such as botanists, ecologists, and zoologists may take field trips which involve strenuous physical activity and primitive living conditions.

Employment

Biological scientists held about 52,000 jobs in 1982. In addition, an almost equal number of persons held biology faculty positions in colleges and universities. (See the statement on college and university faculty elsewhere in the *Handbook*.)

About 14,000 biological scientists worked for the Federal Government in 1982. Over one-quarter worked for the Department of Agriculture, and about one-fifth worked for the National Institutes of Health. Large numbers also were employed by the Department of the Interior and the Defense Department. State and local governments combined employed about 8,500.

Over 12,000 worked in private industry, mostly in the pharmaceutical, chemical, food, and agricultural services industries in 1982. About 4,000 worked for nonprofit research organizations and foundations; a few were self-employed.

Training, Other Qualifications, and Advancement

The Ph.D. degree generally is required for college teaching, independent research, and for advancement to administrative research positions and other management jobs. A master's degree is sufficient for some jobs in applied research. The bachelor's degree is adequate preparation for some beginning jobs, but promotions often are limited for those who hold no higher degree. New graduates with a bachelor's degree can start their careers in testing and inspecting jobs, or become technical sales and service representatives. They also can become senior biology technicians, medical laboratory technologists and technicians or, with courses in education, high school biology teachers. (See the statement on secondary school teachers elsewhere in the *Handbook*.) Many with a bachelors degree in biology enter medical, dental, veterinary, or other health profession schools. Some enter a wide range of occupations with little or no connection to biology.

Most colleges and universities offer bachelor's degrees in biological science and many advanced degrees. Curriculums for advanced degrees in biological science often emphasize a particular area of biological science such as microbiology or botany. Not all universities offer all curriculums. Requirements for advanced degrees usually include fieldwork and laboratory research as well as classroom studies and preparation of a thesis. Biological scientists who have advanced degrees usually begin in research or teaching jobs. With experience, they may advance to jobs such as supervisors of research programs.

Prospective biological scientists should be able to work independently or as part of a team and must be able to communicate their findings clearly and concisely, both orally and in writing. Biological scientists conducting field research in remote areas must have physical stamina.

Job Outlook

Employment of biological scientists is expected to increase faster than the average for all occupations through the mid-1990's due to recent advances in genetic research that should result in new drugs, improved plants, and medical discoveries. Advances in biological technology should result in many additional research jobs for biological scientists in private industry; additional jobs are likely to be created by the production, by biological methods, of products which are presently produced by chemical or other methods. Efforts to preserve the environment should also result in additional employment opportunities. In addition to jobs arising from growth in demand for biological scientists, job openings will occur as some biological scientists transfer to other occupations, retire, or die.

Employment opportunities for biological scientists are expected to be better for those with advanced degrees since most new jobs will be research oriented. Furthermore, the employment outlook will vary by specialty. Those who have the ability to do research in areas related to the genetic, cellular, and biochemical areas of biology should experience better employment opportunities than those in other specialties. However, many persons with a bachelor's degree in biological science find jobs in occupations such as science or engineering technicians or medical laboratory technologists. Some become high school biology teachers. However, they are usually regarded as teachers rather than biologists. (See the statement on secondary school teachers elsewhere in the *Handbook*.) Others enter a wide range of occupations with little or no connection to biology.

Biological scientists rarely lose their jobs during recessions, since most are employed on long-term research projects or in agriculture, activities which are not much affected by economic fluctuations.

Earnings

According to the College Placement Council, beginning salary offers in private industry in 1982 averaged $16,500 a year for bachelor's degree recipients and $17,000 a year for master's degree recipients in biological science.

In the Federal Government in early 1983, biological scientists having a bachelor's degree could begin at $13,369 or $16,559 a year, depending on their college records. Those having the master's degree could start at $16,559 or $20,256, depending on their academic records or work experience; those having the Ph.D. degree could begin at $24,508 or $29,374 a year. Biological scientists in the Federal Government averaged $31,900 a year in 1982.

Related Occupations

Many occupations are related in some way to biological scientists since they deal with living organisms. These include the conservation occupations of foresters, forestry technicians, range managers, and soil conservationists, as well as agricultural scientists, biochemists, soil scientists, oceanographers, and life science technicians. The wide array of health occupations are all related to those in the biological sciences, as are occupations dealing with raising plants and animals such as farmers and farm workers, florists, and nursery workers.

Sources of Additional Information

General information on careers in biological sciences, available from:

American Institute of Biological Sciences, 1401 Wilson Boulevard, Arlington, Va. 22209.

American Physiological Society, Education Officer, 9650 Rockville Pike, Bethesda, Md. 20814.

Dr. Carol C. Baskin, Secretary, Botanical Society of America, School of Biological Sciences, University of Kentucky, Lexington, Ky. 40506.

American Society of Zoologists, P.O. Box 2739, California Lutheran College, Thousand Oaks, Calif. 91360.

For information on careers in horticultural science, send a stamped, self-addressed envelope to:

American Society for Horticultural Science, 701 North Saint Asaph St., Alexandria, Va. 22314.

Information on Federal job opportunities is available from local offices of State employment services and the U.S. Office of Personnel Management or from Federal Job Information Centers located in various large cities throughout the country.

Chemists

(D.O.T. 022.061-010 and -014, 132.061-010, 161.010, and 081.061-026)

Nature of the Work

The clothes we wear, the foods we eat, the houses in which we live—in fact, most things that help make our lives better, from medical care to a cleaner environment—result, in part, from the work done by chemists.

Chemists search for and put to practical use new knowledge about substances. Their research has resulted in the development of a tremendous variety of synthetic materials, such as nylon and polyester fabrics, and processes which help save energy and reduce pollution, such as improved oil refining methods. Research on the chemistry of living things provides the basis for advances in medicine, agriculture, and other areas.

Over 60 percent of all chemists work in research and development. In basic research,

chemists investigate the properties, composition, and structure of matter and the laws that govern the combination of elements and reactions of substances. In applied research and development, they create new products or improve existing ones, often using knowledge gained from basic research. For example, synthetic rubber and plastics have resulted from research on small molecules uniting to form larger ones (polymerization).

The process of developing a product begins with descriptions of the characteristics it should have. If similar products exist, chemists test samples to determine their ingredients. If no such product exists, chemists experiment with various substances to develop a product with the required specifications.

About 10 percent of all chemists work in production and inspection. In production, chemists prepare instructions (batch sheets) for plant workers that specify the kind and amount of ingredients to use and the exact mixing time for each stage in the process or monitor automated processes to ensure proper product yield and quality. At each step, samples are tested for quality control to meet industry and government standards. Chemists keep records and prepare reports showing results of tests. Others work as marketing or sales representatives where they sell and provide technical information on chemical products.

Chemists often specialize in a subfield of chemistry. *Analytical chemists* determine the structure, composition, and nature of substances, and develop new analytical techniques. An outstanding example of the capabilities of this specialty was the analysis of moon rocks by an international team of analytical chemists. *Biochemists* study the chemical composition of living things. They try to understand the complex chemical combinations and reactions involved in reproduction, growth, and heredity. Recent advances in biochemistry have resulted in the discovery of many of the mechanisms of reproduction and heredity, including how to splice genes (a technique called recombinant DNA). These discoveries will probably lead to major advances in medicine and to the development of new products and production processes. *Organic chemists* study the chemistry of carbon compounds. When combined with other elements, carbon forms a vast number of substances. Many modern commercial products, including drugs, plastics, and other synthetics, have resulted from the work of organic chemists. *Inorganic chemists* study compounds other than carbon. They may, for example, develop materials for electronic components. *Physical chemists* study the physical characteristics of atoms and molecules and investigate how chemical reactions work. This research may result in new and better energy sources.

Working Conditions

Chemists usually work regular hours in offices and laboratories. Some are exposed to health or safety hazards when handling certain chemicals, but there is little risk if proper procedures are followed.

Chemists with a bachelor's degree often get jobs analyzing or testing products or assisting senior chemists in research and development laboratories.

Employment

Chemists held about 89,000 jobs in 1982. Almost two-thirds of all chemists work for manufacturing firms—about one-half of these are in the chemical manufacturing industry; the rest are scattered throughout other manufacturing industries. Chemists also work for State and local governments, primarily in health and agriculture, and for Federal agencies, chiefly the Departments of Defense, Health and Human Resources, and Agriculture. Smaller numbers work for nonprofit research organizations. In addition, about 19,000 persons held chemistry faculty positions in colleges and universities in 1982. (See the statement on college and university faculty elsewhere in the *Handbook*.)

Chemists are employed in all parts of the country, but they are concentrated in large industrial areas.

Training, Other Qualifications, and Advancement

A bachelor's degree with a major in chemistry or a related discipline is sufficient for many beginning jobs as a chemist. However, graduate training is required for most research jobs, and most college teaching jobs require a Ph.D. degree. Beginning chemists should have a broad background in chemistry, with good laboratory skills.

Many colleges and universities offer a bachelor's degree program in chemistry. About 550 are approved by the American Chemical Society. In addition to required courses in analytical, inorganic, organic, and physical chemistry, undergraduates usually study mathematics, physics, and liberal arts.

Several hundred colleges and universities award advanced degrees in chemistry. Graduate students generally specialize in a subfield of chemistry. Requirements for the master's and doctor's degree usually include a thesis based on independent research.

Students planning careers as chemists should enjoy studying science and mathematics, and should like working with their hands building scientific apparatus and performing experiments. Perseverance and the ability to concentrate on detail and to work independently are essential. Other assets include an inquisitive mind and imagination.

Graduates with the bachelor's degree generally begin their careers in government or industry by analyzing or testing products, working in technical sales or service, or assisting senior chemists in research and development laboratories. Some in entry level positions are considered chemists, others are considered senior chemical technicians. Employers may have training and orientation programs which provide special knowledge needed for the employer's type of work. Candidates for an advanced degree often teach or do research in colleges and universities while working toward their degrees.

Beginning chemists with the master's degree can usually teach in a 2-year college or go into applied research in government or private industry. The Ph.D. generally is required for basic research, for 4-year college faculty positions, and for advancement to many administrative positions.

Many people with a bachelor's degree in chemistry also enter a wide range of occupations with little or no connection to chemistry. Some enter medical, dental, veterinary, or other health profession schools.

Job Outlook

Employment of chemists is expected to grow about as fast as the average for all occupations through the mid-1990's. In addition to jobs arising from increased demand for chemists, many openings will result each year as chemists transfer to other occupations, retire, or die.

The majority of job openings are expected to be in private industry, primarily in the development of new products. In addition, industrial companies will need more chemists—especially biochemists—to do biotechnology research and to develop products and production processes arising from this research.

Little growth in the employment of chemistry faculty in colleges and universities is expected.

Chemistry graduates may become high school teachers. However, they usually are then regarded as science teachers rather than chemists. Others may qualify as engineers, especially if they have taken some courses in engineering. (See statements on secondary school teachers and engineers elsewhere in the *Handbook*.)

Earnings

According to the College Placement Council, chemists with the bachelor's degree were offered starting salaries averaging $21,000 a year in 1982; those with the master's degree, $23,800; and those with the Ph.D., $32,600.

According to the American Chemical Society, salaries of experienced chemists in private industry having a bachelor's degree averaged $29,000 a year in 1982; for those with a master's degree, $33,000; and for those with a Ph.D., $42,000.

Depending on a person's college record, the annual starting salary in the Federal Government in early 1983 for an inexperienced chemist with a bachelor's degree was either $13,369 or $16,559. Those who had 2 years of graduate study could begin at $20,256 a year. Chemists having the Ph.D. degree could start at $24,508 or $29,374. The average salary for all chemists in the Federal Government in 1982 was $32,800 a year.

Related Occupations

The work of chemical engineers, occupational safety and health workers, agricultural scientists, biological scientists, and chemical technicians is closely related to the work done by chemists. Many manufacturers' sales representatives and wholesale trade sales workers in chemical marketing use a knowledge of chemistry in their work, as do many technical writers. The work of other physical and life science occupations may also be similar to that of chemists.

Sources of Additional Information

General information on career opportunities and earnings for chemists is available from:

American Chemical Society, 1155 16th St. NW., Washington, D.C. 20036.

Information on careers in biochemistry is available from:

American Society of Biological Chemists, 9650 Rockville Pike, Bethesda, Md. 20014.

Information on Federal job opportunities is available from local offices of State employment services and the U.S. Office of Personnel Management or from Federal Job Information Centers located in various large cities throughout the country.

Foresters and Conservationists

(D.O.T. 040.061-030, -034, -046, -050, -054, and -062, 169.167-022, and 451.137-010)

Nature of the Work

Forests and rangelands serve a variety of needs. They provide habitats for wildlife, serve as sites for recreational activities, and supply lumber, minerals, and water. Foresters and conservationists manage, develop, and help protect these and other natural resources.

Foresters plan and supervise the growing, protection, and harvesting of trees. They map forest areas, estimate the amount of standing timber and future growth, and manage timber sales. Foresters also protect the trees from fire, harmful insects, and disease. Some foresters also protect wildlife and manage watersheds; develop and supervise camps, parks, and grazing lands, and do research. Foresters in extension work provide information to forest owners and to the general public.

Range managers, also called *range conservationists*, *range ecologists*, or *range scientists*, manage, improve, and protect rangelands to maximize their use without damaging the environment. Rangelands cover more than 1 billion acres of the United States, mostly in the Western States and Alaska. They contain many natural resources: Grass and shrubs for animal grazing, wildlife habitats, water from vast watersheds, recreation facilities, and valuable mineral and energy resources. Rangelands also serve as areas for scientific study of the environment. Range managers help ranchers attain optimum livestock production by determining the number and kind of animals to graze, the grazing system to use, and the best season for grazing. At the same time, however, they try to conserve the soil and vegetation for other uses such as wildlife habitats, outdoor recreation, and timber.

Soil conservationists provide technical assistance to farmers, ranchers, and others concerned with the conservation of soil, water, and related natural resources. They develop programs that are designed to get the most productive use of land without damaging it. Soil conservationists do most of their work in the field. Conservationists visit areas with erosion problems, find the source of the problem, and develop a program to combat the erosion.

Foresters and conservationists often specialize in one area of work, such as timber management, outdoor recreation, or forest economics.

Working Conditions

Working conditions for foresters and conservationists vary considerably. Their image as solitary horseback riders, singlehandedly protecting large areas of land far from civilization no longer holds true. Modern foresters and conservationists spend a great deal of time working with people. They deal regularly with landowners, loggers, forestry technicians and aides, farmers, and ranchers.

The work can still be physically demanding, though. Many foresters and conservationists often work outdoors in all kinds of weather, sometimes in remote areas. To get to these areas, they use airplanes, helicopters, and four-wheel drive vehicles. Foresters and conservationists also may work long hours fighting fires or on search-and-rescue missions.

Employment

Foresters and conservationists held nearly 31,000 jobs in 1982. About one-half worked for the Federal Government, primarily in the Department of Agriculture. About one-fourth worked for State governments. The remainder worked in private industry, mainly for lumber, paper, and logging companies, and for local governments and consulting firms. A few were self-employed either as consultants or forest owners.

Most soil conservationists work for the Federal Government, mainly with the Department of Agriculture's Soil Conservation Service.

Although foresters and conservationists work in every State, employment is concentrated in the Western and Southeastern States where many national forests and parks are located and where most of the lumber and pulpwood producing forests are located. Range managers work almost entirely in the Western States where rangeland is located. Soil conservationists, on the other hand, are employed in almost every county in the country.

Training, Other Qualifications, and Advancement

A bachelor's degree in forestry is the minimum educational requirement for professional careers in forestry. However, due to keen job

Foresters and conservationists work outdoors in all kinds of weather.

competition and the increasingly complex nature of the forester's work, many employers prefer graduates who hold advanced degrees. Certain jobs such as teaching and research require advanced degrees.

In 1982, about 50 colleges and universities offered bachelor's or higher degrees in forestry; 43 of these were accredited by the Society of American Foresters. Curriculums stress the liberal arts and communications skills as well as technical forestry subjects. Courses in forest economics and business administration supplement the student's scientific and technical knowledge. Many colleges require students to spend one summer in a field camp operated by the college. All schools encourage summer jobs that give experience in forest or conservation work.

A bachelor's degree in range management or range science is the usual minimum educational requirement for range managers. The Federal Government requires at least 42 hours in plant, animal, or soil sciences and natural resources management courses, including at least 18 hours in range management. Graduate degrees in range management generally are required for teaching and research positions and may be helpful for advancement in other jobs.

In 1982, about 18 colleges and universities offered degrees in range management or range science. A number of other schools offered some courses in range management. Specialized range management courses combine plant, animal, and soil sciences with principles of ecology and resource management. Desirable electives include economics, forestry, hydrology, agronomy, wildlife, computer science, and recreation.

Very few colleges and universities offer degrees in soil conservation. Most soil conservationists have degrees in agronomy, agricultural education, or general agriculture; a few have degrees in related fields such as wildlife biology, forestry, and range management. Programs of study generally include 30 semester hours in natural resources or agriculture, including at least 3 hours in soils.

In addition to meeting the intellectual demands of forestry and conservation work, foresters and conservationists must enjoy working outdoors, be physically hardy, and be willing to move often to remote places. They must also be able to work well with people and have good communication skills.

Recent forestry and range management graduates usually work under the supervision of experienced foresters or range managers. After gaining experience, they may advance to more responsible positions. In the Federal Government, an experienced forester may supervise an entire forest area, and may advance to regional forest supervisor or to a top administrative position. In private industry, foresters start by learning the practical and administrative aspects of the business. Many foresters work their way up to top managerial positions within their companies.

Soil conservationists usually begin working within one county and with experience may advance to the area and State level. Also, soil conservationists can transfer to related occupations such as farm management advisors or land appraisers.

Job Outlook

Employment of foresters and conservationists is expected to grow more slowly than the average for all occupations through the mid-1990's. Employment should continue to grow faster in private industry than in Federal and State governments where budget limitations are likely to restrain growth. More foresters will be needed in private industry to ensure an increasing output of forest products. Private owners of timberland also are likely to employ more foresters as they recognize the need for—and the higher profitability of—improved forestry and logging practices. The growing demand for meat, wildlife habitats, recreation, and water, as well as continued environmental concerns should stimulate the need for more range managers. However, the employment of soil conservationists is expected to change little through the mid-1990's since the Federal Government, the major employer, is not expected to increase its employment of soil conservationists. Besides job openings created by growth in employment, many foresters and conservationists will be needed to replace those who retire, transfer to other occupations, or die.

Earnings

Most graduates entering the Federal Government as foresters, range managers, or soil conservationists in early 1983 with just a bachelor's degree started at $13,369 a year, although those with high grades or a master's degree could start at $16,559. In 1982, the average Federal salary for foresters was about $27,900; for range conservationists, about $23,700; and for soil conservationists, about $26,000.

Related Occupations

Foresters and conservationists are not the only workers concerned with managing, developing, and protecting natural resources. Other workers with similar responsibilities include agricultural scientists, agricultural engineers, biological scientists, farmers, farm managers, ranchers, and wildlife managers.

Sources of Additional Information

General information about the forestry profession and lists of schools offering education in forestry are available from:

Society of American Foresters, 5400 Grosvenor Lane, Bethesda, Md. 20814.

American Forestry Association, 1319 18th St. NW., Washington, D.C. 20036.

Information about a career as a range manager as well as a list of schools offering training is available from:

Society for Range Management, 2760 W. 5th Ave., Denver, Colo. 80204.

For information about career opportunities in the Federal Government, contact:

Bureau of Land Management, Denver Service Center, Federal Center Building 50, Denver, Colo. 80225.

U.S. Department of Agriculture, Forest Service, P.O. Box 2417, Washington, D.C. 20013.

U.S. Department of Agriculture, Soil Conservation Service, P.O. Box 2890, Washington, D.C. 20013.

Geologists and Geophysicists

(D.O.T. 024.061-161, and -167)

Nature of the Work

Geologists and geophysicists study the physical aspects and history of the earth. They analyze information collected through seismic prospecting techniques, which involve bouncing sound waves off deeply buried rock layers; examine surface rocks and samples of buried rocks recovered by drilling; and study information collected by satellites. They also identify rocks and minerals, conduct geological surveys, construct maps, and use instruments such as the gravimeter and magnetometer to measure the earth's gravity and magnetic field. An important application of geological research is locating oil and other minerals.

Geologists and geophysicists examine chemical and physical properties of specimens in laboratories under controlled temperature and pressure. They may study fossil remains of animal and plant life or experiment with the flow of water and oil through rocks. Laboratory equipment used includes instruments such as the X-ray diffractometer, which determines the structure of minerals, and the petrographic microscope, used for close study of rock formations.

Besides locating resources and working in laboratories, geologists and geophysicists also advise construction companies and government agencies on the suitability of proposed locations for buildings, dams, or highways. Some administer and manage research and exploration programs.

A geologist studies geological data plotted by a computer

The fields of geology and geophysics are closely related but there are differences. Geologists study the composition, structure, and history of the earth's crust. They try to find out how various rocks were formed and what has happened to them throughout history. Geophysicists use the principles of physics and mathematics to study the earth's internal composition, surface, and atmosphere and also various forces such as its magnetic, electrical, and gravitational fields.

Geologists and geophysicists usually specialize. *Geodesists* study the size, shape, and gravitational field of the earth. Their principal task is to make very precise measurements for mapping the earth's surface. *Hydrologists* study the distribution, circulation, and physical properties of underground and surface waters. They may study the form and intensity of precipitation, its rate of infiltration into the soil, and its return to the ocean and atmosphere. *Mineralogists* analyze and classify minerals and precious stones according to composition and structure. *Paleontologists* study fossils found in geological formations to trace the evolution of plant and animal life. *Seismologists* study and interpret data from seismographs, which measure small movements of the earth, and other instruments to locate earthquakes and earthquake faults. *Stratigraphers* study the distribution and arrangement of sedimentary rock layers by examining their fossil and mineral content. *Meteorologists* sometimes are classified as geophysical scientists. (See the statement on meteorologists elsewhere in the *Handbook*.)

Working Conditions

Most geologists and geophysicists divide their time between fieldwork and office or laboratory work. While in the field, geologists often travel to remote sites by helicopter or jeep and cover large areas by foot. Exploration geologists and geophysicists often work overseas or in remote areas. When not working outdoors, geologists are in comfortable, well-lighted, well-ventilated offices and laboratories.

Employment

Geologists and geophysicists held almost 49,000 jobs in 1982. Over two-fifths were in oil and gas companies, and almost one sixth were in service firms, many of which are involved in oil and gas exploration. Mining and quarrying companies also employ many geologists and geophysicists. Self-employed geologists held about 1 in 6 jobs, primarily as industry and government consultants.

The Federal Government employed almost 5,600 geologists, geophysicists, geodesists, and hydrologists in 1982. Almost two-thirds worked for the Department of the Interior in the U.S. Geological Survey, the Bureau of Mines, and the Bureau of Reclamation. Other Federal agencies that employ geologists and geophysicists include the Departments of Defense, Agriculture, Commerce, and Energy. State agencies also employ geologists and geophysicists, some work on surveys in cooperation with the U.S. Geological Survey. Geologists and geophysicists also work for nonprofit research institutions and museums. Some are employed by American firms overseas for varying periods of time. In addition, about 7,000 persons held geology and geophysics faculty positions in colleges and universities in 1982. (See the statement on college and university faculty elsewhere in the *Handbook*.)

Training, Other Qualifications, and Advancement

A bachelor's degree in geology or geophysics is adequate for entry into some lower level geology jobs, but better jobs with good advancement potential usually require at least a master's degree in geology or geophysics. Persons with strong backgrounds in physics, mathematics, or computer science also may qualify for some geophysics jobs. A Ph.D. degree is essential for most research positions.

Over 500 colleges and universities offer a bachelor's degree in geology and about 75 colleges and universities offer a bachelor's degree in geophysics. Other programs offering training for beginning geophysicists include geophysical technology, geophysical engineering, geophysical prospecting, engineering geology, petroleum geology, and geodesy.

More than 220 universities award advanced degrees in geology and about 70 universities grant advanced degrees in geophysics.

Geologists and geophysicists need to be able to work as part of a team. They should be curious, analytical, and able to communicate effectively. Those involved in fieldwork must have physical stamina.

Geologists and geophysicists usually begin their careers at field exploration or as research assistants in laboratories. With experience, they can be promoted to project leader, program manager, or other management and research positions.

Job Outlook

Employment of geologists and geophysicists is expected to grow about as fast as the average for all occupations through the mid-1990's. In addition to new jobs created by increased demand for geologists, many openings will arise each year as geologists leave the occupation, retire, or die.

Efforts to locate new sources of energy as older sources become exhausted will continue to stimulate domestic exploration activities and create a need for many additional geologists, although exploration activity may vary over the short run depending on the price and demand for oil. Geologists and geophysicists who have knowledge and experience in geophysical oil and gas exploration techniques may experience better employment opportunities than others. Additional geologists and geophysicists will be needed to discover new mineral resources, to devise techniques for exploring deeper within the earth's crust, and to develop more efficient methods of mining. They also will be needed to develop more adequate water supplies and waste disposal methods, and to do site evaluation for construction activities.

Earnings

Median annual earnings of full-time geologists and geophysicists were about $33,000 in 1982; the middle 50 percent earned between $25,000 and $40,000 annually. According to surveys done by the College Placement Council, graduates with bachelor's degrees in physical and earth sciences received average starting offers of $23,800 a year in 1982. Graduates with master's degrees in geology and related geological sciences received average starting offers of $29,000 a year.

In the Federal Government in early 1983, geologists and geophysicists having a bachelor's degree could begin at $13,369 or $16,559 a year, depending on their college records. Those having a master's degree could start at $16,559 or $20,256 a year, those having the Ph.D. degree, at $24,508 or $29,374. In 1982, the average salary for geologists in the Federal Government was about $33,000 a year and for geophysicists, about $35,200 a year.

Related Occupations

Many geologists and geophysicists work in the petroleum and natural gas industry. This industry also employs many other workers who are involved in the scientific and technical aspects of petroleum and natural gas exploration and extraction, including drafters, engineering technicians, laboratory assistants (petroleum production), petroleum engineers, and surveyors. Also related to the work of geologists and geophysicists are other physical science occupations such as physicists, chemists, meteorologists, and oceanographers as well as mathematicians and computer scientists.

Sources of Additional Information

Information on training and career opportunities for geologists is available from:

American Geological Institute, 5202 Leesburg Pike, Falls Church, Va. 22041

Information on training and career opportunities for geophysicists is available from:

American Geophysical Union, 2000 Florida Ave. NW., Washington, D.C. 20009

Society of Exploration Geophysicists, P.O. Box 3098, Tulsa, Okla. 74101

For information on Federal Government careers, contact:

U.S. Office of Personnel Management, 1900 E St. NW., Washington, D.C. 20415

Meteorologists

(D.O.T. 025.062-010)

Nature of the Work

Meteorology is the study of the atmosphere, which is the air that surrounds the earth. Meteorologists try to understand the atmosphere's physical characteristics, motions, and processes, and determine the way the atmosphere affects the rest of our environment. The best known application of this knowledge is in understanding and forecasting the weather. However, weather information and meteorological research also is applied in many other areas, such as air pollution control, fire

prevention, agriculture, air and sea transportation, and studying trends in the earth's climate.

Meteorologists who forecast the weather, known professionally as *operational or synoptic meteorologists*, are the largest group of specialists in this field. They study past and current weather information, such as air pressure, temperature, humidity, and wind velocity, and apply physical and mathematical relationships to make short-range and long-range predictions. Their data come from weather satellites and observers in many parts of the world. Although some forecasters still prepare and analyze weather maps, most data now are plotted and analyzed by computers.

Some meteorologists engage in basic and applied research. For example, *physical meteorologists* study the chemical and physical properties of the atmosphere. They do research on the effect of the atmosphere on transmission of light, sound, and radio waves, as well as study factors affecting formation of clouds, rain, snow, and other weather phenomena. Other meteorologists, known as *climatologists*, study trends in climate and analyze past records on wind, rainfall, sunshine, and temperature to determine the general pattern of weather that makes up an area's climate. These studies are used to plan heating and cooling systems, design buildings, and aid in effective land utilization.

Working Conditions

Jobs in weather stations, most of which operate around the clock 7 days a week, often involve night work and rotating shifts. Most stations are at airports or in or near cities; some are in isolated and remote areas. Meteorologists in smaller weather stations generally work alone; in larger ones, they work as part of a team.

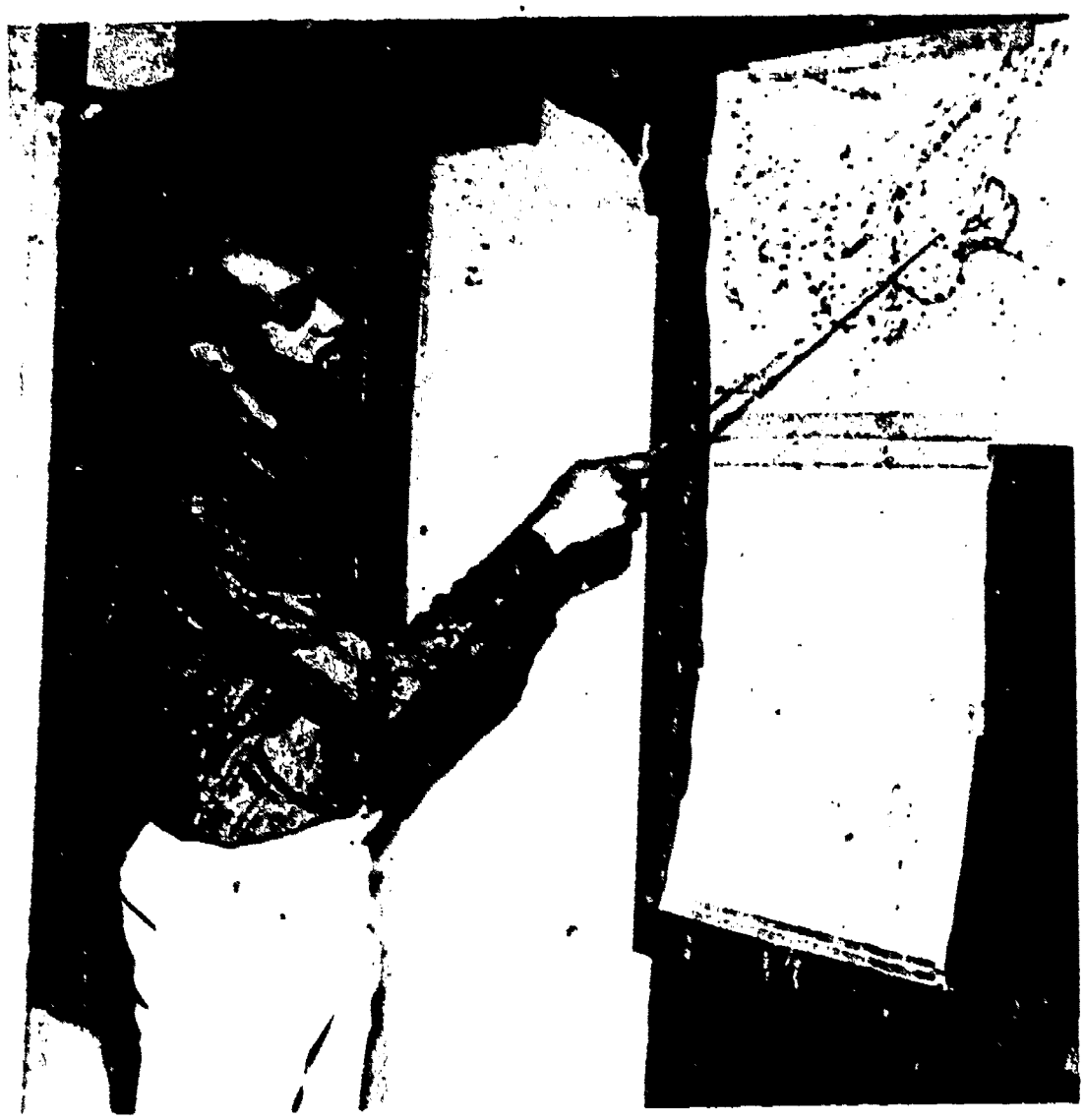
Employment

Meteorologists held about 3,700 jobs in 1982. In addition, about 1,000 persons held meteorology faculty positions in colleges and universities in 1982. (See the statement on college and university faculty elsewhere in the *Handbook*.)

The largest employer of civilian meteorologists was the National Weather Service, where about 1,800 worked at stations in all parts of the United States and in a small number of foreign areas. The Department of Defense employed almost 200 civilian meteorologists. A few worked for State and local governments and for nonprofit organizations.

In addition to government, private weather consulting firms and radio and television stations employed many meteorologists. Commercial airlines also employed meteorologists to forecast weather along flight routes and to brief pilots on atmospheric conditions. Other meteorologists worked for companies that design and manufacture meteorological instruments or for firms in aerospace, engineering, utilities, and other industries.

In addition to civilian meteorologists, thousands of members of the Armed Forces did forecasting and other meteorological work.



Employment of meteorologists is expected to grow more slowly than the average for all occupations through the mid-1990's.

Training, Other Qualifications, and Advancement

A bachelor's degree with a major in meteorology is the usual minimum requirement for beginning jobs in weather forecasting. However, employers prefer to hire those with an advanced degree, and an advanced degree is increasingly necessary for promotion.

For research and college teaching and for many top level positions in other meteorological activities, an advanced degree, preferably in meteorology, is essential. People with graduate degrees in other sciences also may qualify if they have advanced courses in meteorology, physics, mathematics, and chemistry.

In 1982, about 35 colleges and universities offered a bachelor's degree in meteorology or atmospheric science; about 40 schools offered advanced degrees. Many other institutions offered some courses in meteorology. Before selecting a degree program in meteorology, students should investigate the particular emphasis of the program, since many meteorology programs are combined with the study of a related scientific or engineering field.

Beginning meteorologists often start in jobs involving routine data collection, computation, or analysis. Experienced meteorologists may advance to various supervisory or administrative jobs. A few very well qualified meteorologists with a background in business administration may establish their own weather consulting services.

Job Outlook

Employment of meteorologists is expected to grow more slowly than the average for all occupations through the mid-1990's. Little or no growth in employment is expected in the National Weather Service, which employs most meteorologists. Some new jobs will be created in private industry as companies recognize the value of having their own weather forecasting and meteorological services but most of the job openings in this very small occupation will arise from the need to replace those who change occupations, retire, or die. Persons with an advanced degree in meteorology should have the best job prospects.

Earnings

The average salary for meteorologists employed by the Federal Government was $34,200 in 1982. In early 1983, meteorologists in the Federal Government with a bachelor's degree and no experience received starting salaries of $13,369 or $16,559 a year, depending on their college grades. Those with a master's degree could start at $16,559 or $20,256; those with the Ph.D. degree, at $24,508 or $29,374. However, the National Weather Service hired few professional level meteorologists in 1983; instead it hired meteorological technicians, most at a starting salary of $13,369. Qualified meteorological technicians in the National

Weather Service may eventually be promoted to professional meteorologists.

Related Occupations

Workers in other occupations concerned with the physical environment include forest ecologists, foresters, geologists, geophysicists, oceanographers, range managers, and soil conservationists.

Sources of Additional Information

Information on career opportunities in meteorology is available for 75 cents from:

American Meteorological Society, 45 Beacon St., Boston, Mass. 02108.

For facts about job opportunities with the National Weather Service, contact:

National Weather Service, Personnel Section, Gramax Bldg., 8060 13th St., Silver Spring, Md. 20910.

Physicists

(D.O.T. 023.061-010, -014, -067-010, 041.061-034, 079.021-010 and -014)

Nature of the Work

The flight of the space shuttle, the accuracy of advanced medical instruments, and even the safety of the family car depend on research by physicists. Through systematic observation and experimentation, physicists use mathematical terms to describe the structure of the universe and the interaction of matter and energy. Physicists also develop theories that describe the fundamental forces and laws of nature. Determining the basic laws governing phenomena such as gravity, electromagnetism, and nuclear interactions leads to discoveries and innovations that advance nuclear energy, electronics, communications and aerospace technology, and medical instrumentation.

Astronomy is usually considered a subfield of physics. Astronomers use the principles of physics and mathematics to answer questions about the fundamental nature of the universe, such as its origin and history and the evolution of the solar system.

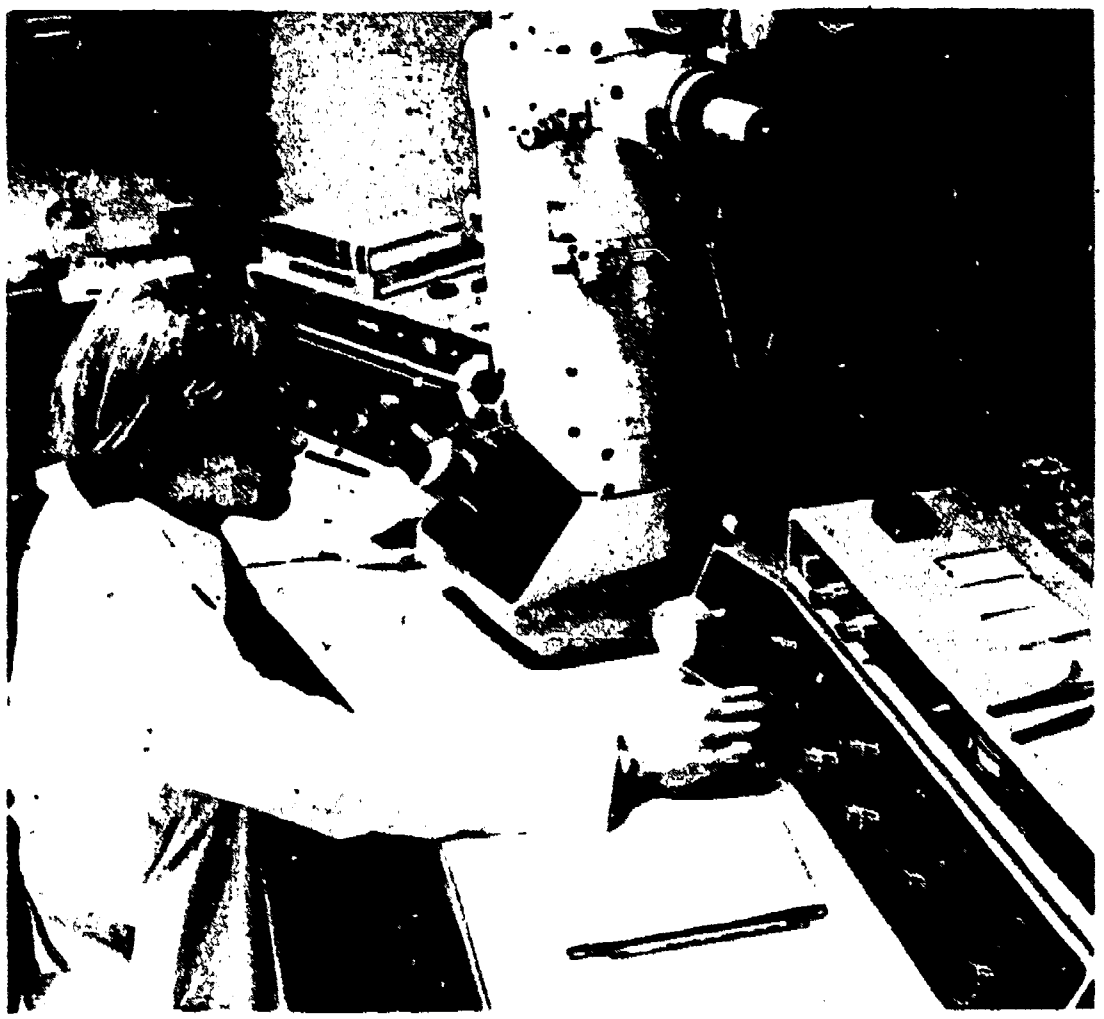
Most physicists work in research and development. Some do basic research to increase scientific knowledge. For example, they investigate the structure of the atom or the nature of gravity. The equipment that physicists design for their research can often be applied to other areas. For example, lasers (devices that amplify light and emit it in a highly directional, intense beam) are utilized in surgery; microwave devices are used for ovens; and measurement techniques and instruments can detect the kind and number of cells in blood or the amount of mercury or lead in foods.

Many physicists conduct applied research and help develop new devices, products, and processes. For instance, their knowledge of solid-state physics led to the development of transistors and then to the integrated circuits used in calculators and computers. A small number work in inspection, testing, quality control, and other production-related jobs in industry. Some do consulting work.

Almost all astronomers do research. Most of their time is spent analyzing the large quantities of data collected by their own and others' observations and writing scientific papers on the results of their research. Most astronomers spend only a few weeks each year making observations with telescopes, radio telescopes, and other instruments (some in orbiting satellites) that can detect electromagnetic radiation from distant sources. Contrary to the popular image, astronomers almost never actually look through a telescope because photographic and electronic radiation detecting equipment is more effective than the human eye.

Most physicists specialize in one or more branches of the science—elementary particle physics; nuclear physics; atomic, electron, or molecular physics; physics of condensed matter; optics; acoustics; health physics; plasma physics; and the physics of fluids. Some specialize in a subdivision of one of these branches. For example, subdivisions of solid-state physics include superconductivity, crystallography, and semiconductors. However, since all physics involves the same fundamental principles, several specialties may overlap, and in the course of their careers physicists frequently switch from one subfield to another.

Growing numbers of physicists are specializing in fields such as biophysics, chemical physics, and geophysics in which physics and a related science are combined. Furthermore, the practical applications of physicists' work increasingly have merged with engineering.



Graduate training in physics or a closely related field is essential for most entry level jobs in physics.

Working Conditions

Physicists generally work regular hours in laboratories, classrooms, and offices. Most physicists do not encounter unusual hazards in their work. Astronomers who make observations may need to travel to observation facilities which are usually in remote locations and frequently work at night.

Employment

Physicists held almost 19,000 jobs in 1982. In addition, about an equal number of persons held physics faculty positions in colleges and universities. (See the statement on college and university faculty elsewhere in the *Handbook*.) Private industry employed almost two-thirds of all nonacademic physicists, primarily in companies manufacturing electrical equipment, aircraft and missiles, chemicals, and scientific instruments. Many others worked as researchers in colleges and universities, hospitals, commercial laboratories, and independent research organizations. The Federal Government, mostly the Departments of Defense and Commerce, employed about 3 out of 10 physicists.

Although physicists are employed in all parts of the country, their employment is greatest in areas that have heavy industrial concentrations and large college and university enrollments.

Training, Other Qualifications, and Advancement

Graduate training in physics or a closely related field is almost essential for most entry level jobs in physics and for advancement. The doctorate

usually is required for full faculty status at colleges and universities and for industrial or government jobs administering research and development programs. A doctorate is also the usual requirement for a job in astronomy.

Those having master's degrees may qualify for some research jobs in private industry and in the Federal Government as well as for teaching jobs in 2-year colleges. In universities, some teach and assist in research while studying for their Ph.D.

Those having bachelor's degrees may qualify for a few applied research and development jobs in private industry and in the Federal Government. Some are employed as research or teaching assistants in colleges and universities while studying for advanced degrees. Many with undergraduate physics degrees work in engineering and other scientific fields. (See statements on engineers, geologists and geophysicists, programmers, and systems analysts elsewhere in the *Handbook*.)

Almost 800 colleges and universities offer a bachelor's degree in physics. The undergraduate program provides a broad background in the science and serves as a base for later specialization either in graduate school or on the job. Some typical physics courses are mechanics, electromagnetism, electronics, optics, thermodynamics, and atomic and molecular physics. Students also take courses in chemistry and many courses in mathematics.

About 270 colleges and universities offer advanced degrees in physics. In graduate school, the student, with faculty guidance, usually works in a specific subfield of physics. Graduate students, especially candidates for Ph.D. degrees, spend a large portion of their time conducting research.

About 50 universities offer the Ph.D. degree in astronomy. These programs include advanced courses in astronomy, physics, and mathematics. Some schools require that graduate students spend several months working at an observatory. The usual qualification for entrance to a graduate program in astronomy is a bachelor's degree in astronomy, physics, or mathematics with a physics minor.

Students planning a career in physics should have an inquisitive mind, mathematical ability, and imagination. They should be able to work on their own, since physicists, particularly in basic research, often receive only limited supervision.

Physicists, especially those who hold less than a Ph.D., often begin their careers doing routine laboratory tasks. After some experience, they are assigned more complex tasks and may advance to work as project leaders or research directors. Some work in top management jobs. Physicists who develop new products or processes sometimes form their own companies or join new firms to exploit their own ideas.

Job Outlook

Employment opportunities in physics are expected to be good through 1995 for persons with a doctorate in physics because employment is projected to grow faster than the average for all occupations over the period and the number of graduate degrees awarded annually in physics has been declining since 1970. However, persons seeking jobs in astronomy are expected to continue to encounter competition for the small number of available openings that will occur through 1995. Despite the faster than average growth projected in this occupation, most job openings will arise as physicists transfer to other occupations, retire, or die.

Many physicists work in research and development (R&D). The anticipated increase in R&D expenditures through 1995 should result in increased employment for physicists. If actual R&D expenditure levels and patterns differ significantly from those assumed, however, the outlook would be altered.

Some with advanced degrees in physics will be needed to teach in colleges and universities, but opportunities will be better in private industry. Since little employment growth is expected in colleges and universities, most openings in this area will result from the need to replace those who leave the occupation.

Persons with only a bachelor's degree in physics are not qualified to enter most physicist jobs. However, many with bachelor's degrees in physics find jobs as engineers, technicians, or computer specialists. Others become high school physics teachers. However, they are usually regarded as teachers rather than as physicists. (See the statement on secondary school teachers elsewhere in the *Handbook*.)

Earnings

Median annual earnings of full time physicists were about $33,000 in 1982; the middle 50 percent earned between about $28,000 and $45,000 annually.

According to an American Institute of Physics Survey of 1982 degree recipients, starting salaries for physicists in private industry averaged about $26,500 for those with a master's degree and $34,000 for those with a Ph.D.

Depending on their college records, physicists with a bachelor's degree could start in the Federal Government in early 1983 at either $13,369 or $16,559 a year. Beginning physicists having a master's degree could start at $16,559 or $20,256, and those having the Ph.D. degree could begin at $24,508 or $29,374. Average earnings for all physicists in the Federal Government in 1982 were $38,400 a year.

Starting salaries for physics college and university faculty with the Ph.D. averaged $23,000 in 1982, according to the American Institute of Physics. (See the statement on college and university teachers elsewhere in the *Handbook*.) Many faculty physicists supplement their regular incomes by working as consultants and taking on special research projects.

Related Occupations

Physics is closely related other scientific occupations such as chemistry, geology, and geophysics. Engineers and engineering and science technicians also use a knowledge of the principles of physics in their work.

Sources of Additional Information

General information on career opportunities in physics is available from:

American Institute of Physics, 335 East 45th St, New York, N.Y. 10017

For a pamphlet containing information on careers in astronomy and on schools offering training in the field, send 25 cents to:

Dr. Harry Shipman, Education Officer, American Astronomical Society, University of Delaware, Newark, Del. 19711

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