Careers for WOMEN in the PHYSICAL SCIENCES

U.S. DEPARTMENT OF LABOR
James P. Mitchell, Secretary

WOMEN'S BUREAU
Mrs. Alice K. Leopold, Director

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Barber, Mildred Sheridan.

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Note

This report and two others, on employment opportunities for women in engineering and in mathematics and statistics, replace Women's Bureau reports on the same subjects in an earlier series. Additional information on the biological sciences, engineering, the social sciences, and technicians may be found in the current edition of the *Occupational Outlook Handbook*, published by the U.S. Department of Labor's Bureau of Labor Statistics.

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Foreword

The acute need for qualified scientists today makes these fields attractive as lifetime careers for women. Because of this, the Women's Bureau has undertaken to review the kinds of work women are already doing in the physical sciences, some of their contributions, and the employment prospects for them. The rapid growth of the demand for such scientists has resulted in shortages in personnel to fill many openings in industry, government, and classrooms. As a result, this is a favorable time for young women with the required capabilities to prepare for scientific work.

Today women represent a small proportion of scientists. It is especially important for the woman who wishes to become a successful scientist to obtain thorough training, including graduate education in her specialty. This report discusses the basic preparation recommended for a scientific career, the job outlook in a few major scientific fields of interest to women, the kinds of work for which women scientists may prepare, and the rewards such work offers. It analyzes data from the National Register of Scientific and Technical Personnel on the employment, education, types of work, and characteristics of women scientists.

While the discussion of each of the selected sciences is necessarily brief and in no sense exhaustive, it is our hope that it will be sufficiently descriptive to provoke further inquiry and to indicate possible avenues for exploration on the part of counselors, parents and young women of ability. Women have achieved success and made valuable contributions to science in the past and—with their own special talents, the proper training, and increasing public encouragement—will make greater contributions to the scientific progress of our Nation in the future.

Alice K. Leopold,
Director, Women's Bureau.

Acknowledgments

This report, which supersedes earlier Women's Bureau reports on these fields, was prepared by Mildred S. Barber, Evelyn S. Spiro, and Agnes W. Mitchell under the general direction of Stella P. Manor, Chief of the Division of Program Planning, Analysis, and Reports in the Women's Bureau of the Department of Labor.

The National Science Foundation (an agency of the Federal Government), through its National Register of Scientific and Technical Personnel, made valuable contributions to this publication by providing detailed tabulations of the characteristics of women scientists who responded to the 1954-55 Register.

Information collected by the Bureau of Labor Statistics in connection with the Occupational Outlook program was also very helpful, particularly with regard to estimates of the number of scientists.

Special acknowledgment is due each of the scientific societies represented, as well as outstanding individual women members of these societies, for their review of the manuscript. Valuable suggestions were made by the American Astronomical Society, American Chemical Society, American Geological Institute, American Meteorological Society, and American Institute of Physics, as well as by representatives of the National Science Foundation, and of Sigma Delta Epsilon (Graduate Women's Scientific Fraternity).

For the pictures of women scientists, some of which were photographed especially for this bulletin, the Women's Bureau is indebted to the following:

Atomic Energy Commission (pp. 15, 30).

Atlantic Research Corp. (p. 21).

Gulf Oil Co. (p. 23).

National Bureau of Standards, U.S. Department of Commerce (pp. 10, 26, 31).

Standard Oil Company of New Jersey (p. 37).

U.S. Naval Observatory (pp. vi, 44, 45).

U.S. Navy (p. 57).

Weather Bureau, U.S. Department of Commerce (p. 50).

Westinghouse Electric Corp. (pp. 6, 7, 20).

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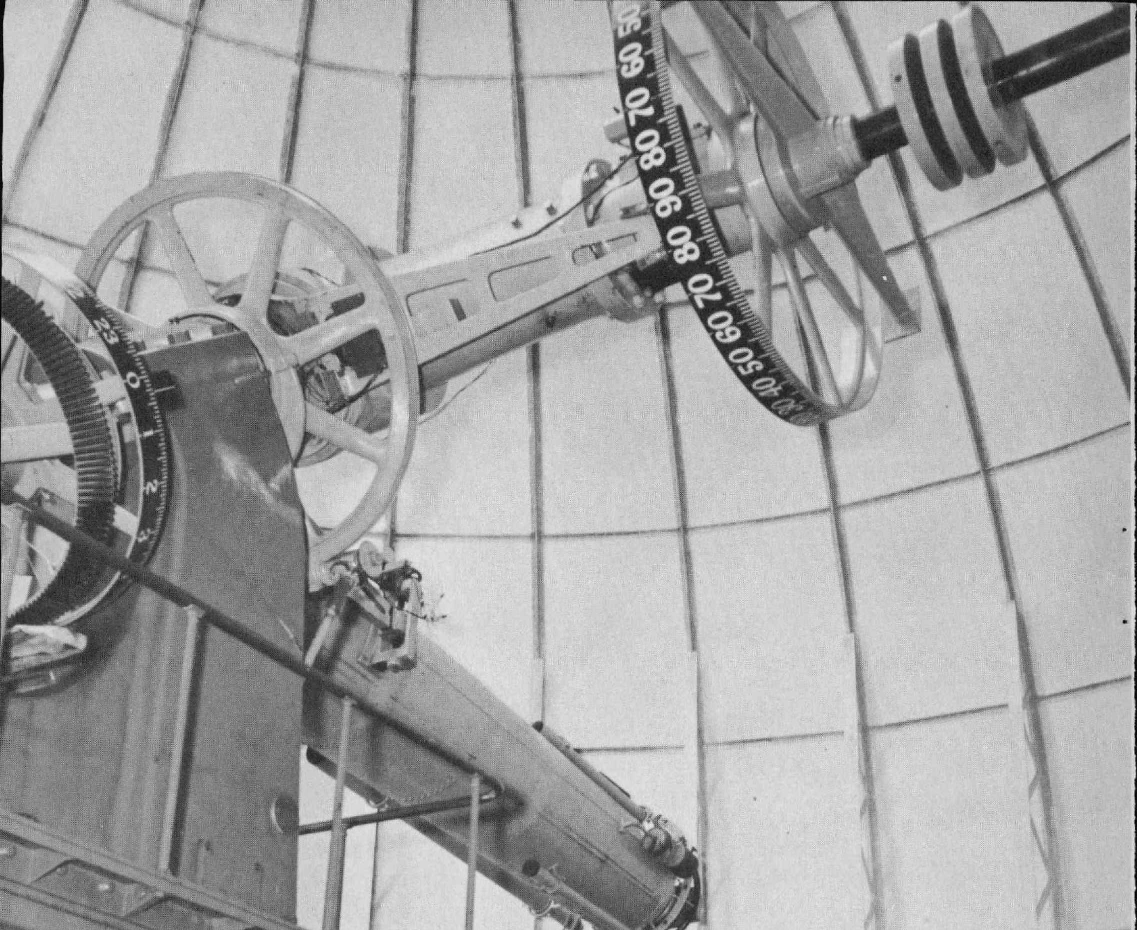

Science and womanpower

The Need for Women Scientists

In April 1956, President Eisenhower established a Committee on Scientists and Engineers to "foster the development of more highly qualified technological manpower." In the Committee's Second Interim Report to the President on October 4, 1957, the following statements appear:

> . . . Obviously, steps must be taken to break down employment barriers to women in science, engineering, and the technician fields. Public education programs of many varieties are needed to encourage young women to undertake science and engineering studies and to ensure that they receive satisfactory employment after training. Employment requirements and specifications, job content, employment conditions, and environment need to be reconsidered. Long established prejudices against women in engineering and science need to be broken down not only among employers, supervisors, and co-workers but among the women themselves.
>
> In its publications and public statements, the Committee has pointed out the advantage and, indeed, the necessity of developing the full potential of the Nation's womanpower qualified for scientific and technological pursuits.

Clearly, the Nation needs qualified women scientists, and those women who are interested and have the capacity should be encouraged to consider careers in scientific fields.

In 1959, the American Council on Women in Science was established by interested scientists from a variety of scientific organiza-

In this modern day race toward the moon and planets, the science of astronomy plays a decisive role, and roughly 15 percent of our astronomers are women.

tions. The creation of this council with the objective of encouraging the more extensive participation of women in science is dramatic evidence of the urgent need for more scientists.

Many women have personal qualities of special value for scientific work. Among these are an inquiring mind; imagination; and a penchant for detail, for orderly, logical thinking, for precise description and measurement, and for critical analysis of facts and theories. The basic requirements common to all scientific fields are interest and a mental capacity that can be developed through specialized training to solve problems and search for a deeper understanding of the nature of things.

So many different abilities and interests are called for in the various sciences and specializations within the sciences that there are activities for practically everyone who has sufficient motivation and intelligence. Some scientists choose academic life; others prefer to work for private industry; while still others prefer working for government. Some desire regular work schedules in an office or laboratory, and others prefer assignments which require travel. Some scientists like to do the planning or to work by themselves, while others offer their best contributions when part of a team. The need has been pointed out for "the observer, the gatherer of facts, the experimenter, the statistician, the theorist, the classifier, the technical expert, the interpreter, the critic, the teacher, the writer."[1]

At a meeting of representatives of women's colleges, industry, government, and educational and medical institutions,[2] the persistence of certain outmoded conceptions (such as the view that it is not feminine to study science) was cited as one of the greatest hindrances to educating women in scientific fields. The conference recognized the cultural values gained by women who study the physical sciences and held that such disciplines sharpen the student's logical thinking. It was further pointed out that this kind of training leads to an understanding of the physical world and to a constructive curiosity as to the cause and effect of the economic, political, and social developments.

The conference observed that young women today may combine both marriage and career and need not face a choice between them. Many women work before marriage and often for a period thereafter, and a large number resume their careers when their children enter

[1] Quoted by Russell B. Stevens in *Career Opportunities in Biology*. Row, Peterson & Co., Evanston, Ill. 1956.

[2] Conference on The Role of Women's Colleges in the Physical Sciences held at Bryn Mawr, Pa., June 17–18, 1954.

school or at some later time. A further point made was that even if a married woman does not return to work, her previous employment will have helped her become a more alert citizen, a more understanding wife, a more capable mother, and a more interesting individual. Moreover, many women marry men in their own fields of endeavor and undoubtedly enhance the scientific contributions of their husbands.

Degrees in Science for Women

The last 5 years have shown a steady rise in the number of women receiving degrees in physical sciences, following a year-by-year decline for at least 5 years prior. Over the entire period 1947–48 through 1957–58, the total number of degrees granted to women was rising almost steadily. (See table 1.)

The following table provides detailed information on the year-by-year changes in degrees granted to women since 1948.

TABLE 1.—DEGREES GRANTED TO WOMEN, 1947–48 THROUGH 1957–58

[All levels]

Academic year	All fields		Physical sciences [1]	
	Total degrees	Percent change from previous year	Total degrees	Percent change from previous year
1957–58	145, 126	+4	2, 006	+5
1956–57	139, 171	+5	1, 905	+6
1955–56	132, 639	+7	1, 789	+9
1954–55	124, 089	−1	1, 641	+9
1953–54	124, 871	(2)	1, 511	+1
1952–53	124, 863	−1	1, 503	−7
1951–52	125, 605	+1	1, 613	−6
1950–51	124, 584	+3	1, 710	−17
1949–50	121, 540	+3	2, 051	−13
1948–49	118, 537	+8	2, 344	−13
1947–48	110, 168		2, 696	

[1] Certain classification changes have been made since 1947–48 when the U.S. Office of Education began publishing its series of annual reports on earned degrees. Limited data on earned degrees published prior to that time are not comparable with annual data for the past 10 years. In particular, the 1955–56 survey expanded the definition of "education" to include science education as well as art, business, and nursing education. As a result, beginning in 1956, some recipients of degrees previously classified as science majors were classified as education majors.

[2] Less than 1 percent change.

SOURCE: U.S. Department of Health, Education, and Welfare, Office of Education. Annual reports for the academic years 1947–48 through 1957–58, Earned Degrees Conferred by Higher Educational Institutions.

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Beginning in 1953–54, there was a very slight rise in the number of degrees granted to women in the physical sciences. In every year since then, however, the rate of increase in degrees granted to women in the physical sicences has exceeded that for degrees in all fields.

Thus, the number of degrees in physical sciences being granted to women today is higher than at any time during the past decade, except for the postwar years. The figures for 1948 through 1950 reflected, in part, the relatively large numbers of young women who were encouraged during the war years to enter scientific, engineering, and technical fields.

During the school year ending in June 1958, 6,165 women received degrees in science, of which 2,006 were in the physical sciences. More than 400 were in general science. The majority—3,724—were in the biological sciences, however, which have traditionally attracted large numbers of women. Less than 5 percent of all women college graduates majored in science—as compared with 10 percent of men graduates. In the five fields of physical science covered in this report, 1,565 women received a bachelor's degree; 215 received a master's degree; and 65 received a doctor's degree.

The following table provides details on degrees in science granted to women during the school year 1957–58, with each of the fields covered in this report separately identified. In almost every instance the number exceeds that for 1956–57.

TABLE 2.—SCIENCE DEGREES GRANTED TO WOMEN, 1957–58

Selected sciences	Total	Bachelor's degree	Master's degree	Doctor's degree
Total	6, 165	5, 247	714	204
Physical sciences	2, 006	1, 669	271	66
Astronomy	13	8	1	4
Chemistry	1, 521	1, 305	167	49
Geology	128	104	21	3
Meteorology	5	4	1	----------
Physics	178	144	25	9
Physical sciences [1]	161	104	56	1
Biological sciences	3, 724	3, 182	404	138
General science [2]	435	396	39	----------

[1] Not elsewhere classified.
[2] Includes graduates specializing in the physical and biological sciences but without specific major.
SOURCE: U.S. Department of Health, Education, and Welfare, Office of Education. Earned Degrees Conferred by Higher Educational Institutions, 1957–58.

By far the majority of women physical science graduates majored in chemistry, and the largest number of women scientists were employed in this field. It would appear that the women who prepare themselves for careers in science usually find employment in the field of their choice. With the current emphasis on science and greater recognition of the Nation's need to utilize fully all of our scientific talent, women may find increasing opportunity in a wider variety of sciences.

Of course, not all women graduates who major in science enter employment as scientists immediately after graduation. Some marry; some enter graduate school; and some find employment in fields other than science. A 1958 survey representing almost 88,000 women receiving bachelor's degrees in June 1957 was conducted by the Women's Bureau in cooperation with the National Vocational Guidance Association. Employment status was reported for an estimated 1,500 women graduates with a major in the physical sciences. Of these, 71 percent were employed 6 months after graduation; 21 percent were continuing their schooling; 1 percent were still seeking work; and 7 percent were neither employed, in school, nor seeking work. Among the employed, 43 percent were working as chemists; 15 percent were in biology, primarily as biological technicians; 15 percent were teaching; and the remainder were office workers or engaged in mathematics or some other professional work.

Recent college enrollment figures show that the prospects for continued growth in the study of sciences are encouraging. According to the second annual survey of third-year college students majoring in science or mathematics, a substantial gain—nearly 25 percent—was reported by the U.S. Office of Education for women majoring in a general science program, from November 1957 to November 1958. More modest advances in this same period were recorded for women in the physical sciences (8 percent) and in the biological sciences (5 percent). Assuming that 80 to 90 percent of these third-year women science students complete their undergraduate studies, more than 6,500 bachelor's degrees in science will be granted to women in 1959–60. This estimate compares with about 5,200 bachelor's degrees in science granted to women in 1957–58.

Number of Women Scientists

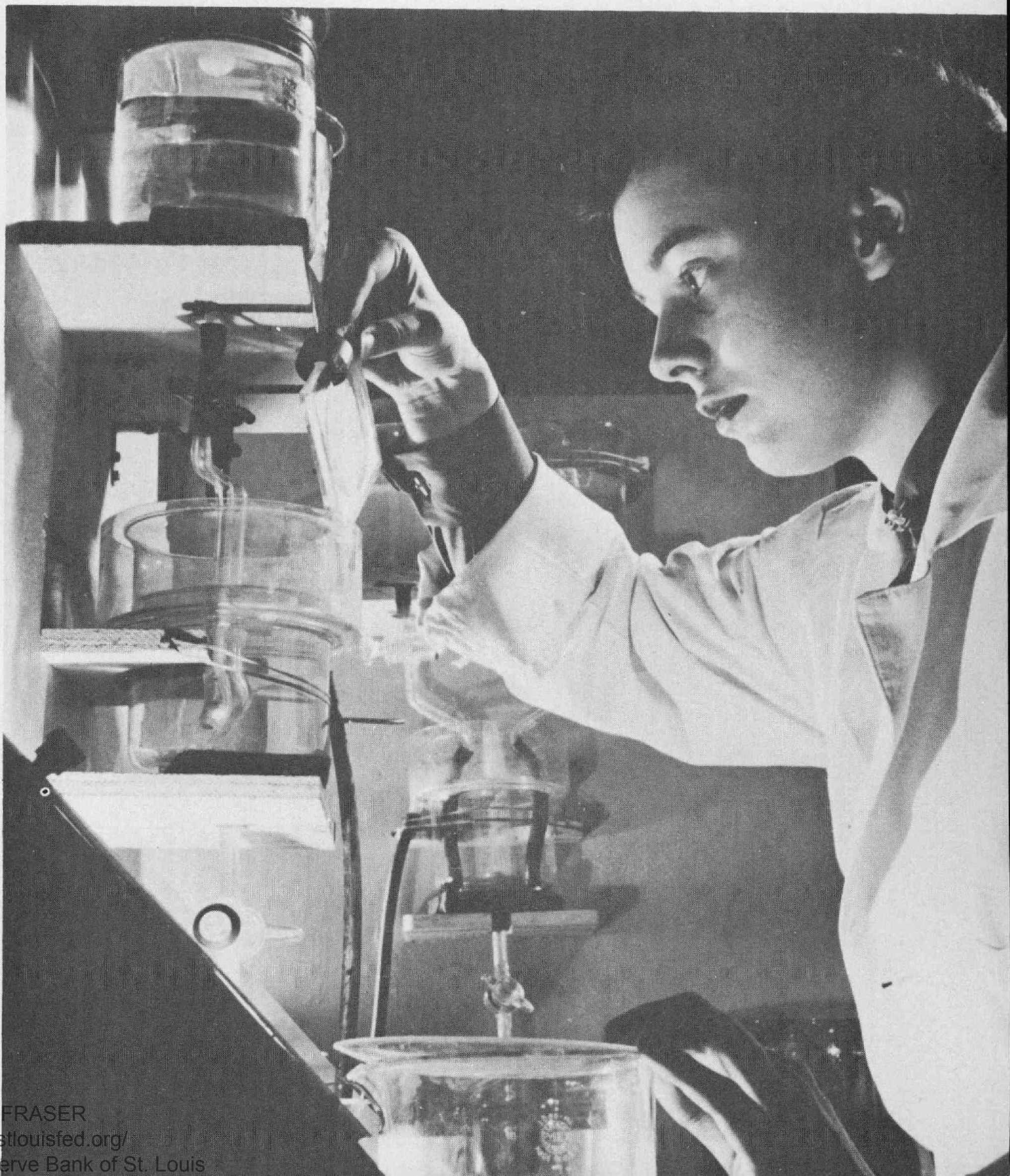
While the actual number of women scientists in each of the five physical sciences covered in this report is not known, estimates for 1958 indicate that about 14,000 women (of a total of better than 170,000 scientists) are found in these five fields: namely, astronomy, chemistry, geology, meteorology, and physics.

An atomic scientist from a leading industrial laboratory uses a giant four million volt atom smasher to search for the unknown forces that hold matter together.

Among the physical scientists (both men and women), chemists are the most numerous. In the case of women, the vast majority—almost 90 percent—are chemists. Nevertheless, some women are found in all these fields. (See p. 8.)

Precise counts of the number of scientists are very difficult to obtain for a number of reasons. Among them is the fact that many scientists hold more than one degree at the same educational level, with a different field of major for each degree, or hold degrees at advanced levels in different major fields. For example, a scientist may hold the bachelor's degree in biology and also in chemistry; or, she may hold a bachelor's degree in mathematics, a master's degree in astronomy, and a Ph. D. in physics. As a result, such a person may be employed in one of these specialties but report herself as a specialist in another, or may be active in the professional society for one field and not the other. Furthermore, she may transfer her interest and employment from one field to another. Thus, some scientists who are trained in one field of specialization are actively engaged in a

Making millionth-of-an-inch films from aluminum foil for experimental electronic tubes is one of the many types of laboratory work for women.



related field, illustrating the interrelationship between several scientific fields and, to some extent, the degree to which mathematics, for example, is basic to all of these fields.

Employers use a variety of classifications and titles for the same type of work, and some science teachers (particularly those in secondary schools) identify themselves as teachers rather than scientists.

The estimates provided in the following summary are based primarily on information supplied by professional societies in each of the fields specified. Some inaccuracies may occur in these figures, also, because not all scientists are members of a professional association, and others belong to more than one association. In general, however, with the possible exception of chemists, these estimates are likely to be understated rather than overstated, particularly for the women.

Scientific specialty	*Estimated total*	*Estimated number of women*
Astronomers	500	75
Chemists	120, 000	12, 000
Geologists	14, 000	400
Meteorologists	6, 000	100
Physicists	30, 000	900

NOTE.—Estimates of the total number of scientists in each specialty were provided by the Bureau of Labor Statistics. Estimates of the number of women scientists have been derived by applying estimates of the percentage of women in each field to the totals.

Women's participation in scientific work goes beyond what these estimates would indicate, of course, as evidenced by the fact that large numbers of women are found in other specialties which are very closely allied to science. For example, medical technology, nursing, dietetics, and medical therapy are fields of applied science in which many thousands of women are employed. And, as previously mentioned, there are many women teachers of science in secondary schools who are not counted among scientists. Thus, women's interest in science is illustrated in many of the careers which they pursue. It is hoped that, with more encouragement and opportunity, a greater number of women will seek careers in the theoretical or pure sciences.

Preparing for a career

Science is primarily a quest for new knowledge. The scientist is interested in studying the basic laws which govern the operation of nature and in learning thereby to assist in increasing the health, comfort, security, and enlightenment of mankind.

Today, the rapid accumulation of scientific knowledge is such that a thorough educational preparation is necessary for a career. Education can provide a broad foundation for understanding new developments, training in the use of scientific methods, and competency in one or more specializations in the chosen field. Even genius cannot take the place of these three essentials, which must be acquired through years of concentrated training.

Education

The bachelor's degree with a major in a particular field of science is considered the minimum requirement for entry jobs in the sciences. Because of the general trend toward higher levels of education in all the sciences, however, even holders of the bachelor's degree employed as computers, data analysts, laboratory workers, assistants to scientists doing original work, or technicians, may be given routine duties. As a result, many science graduates who obtain beginning jobs immediately after receiving the bachelor's degree continue to study at night in order to qualify for the master's or doctor's degree. Other arrangements designed to help young scientists obtain advanced degrees include part-time or full-time jobs that permit the employee to take daytime courses and to make up lost work hours during evenings and weekends.

For many positions, especially those in college teaching, advanced degrees are preferred for entry by beginners and required for advancement. In a sense, women scientists are still pioneering in fields in which men predominate and, therefore, they should be sure that their training is at least the equivalent of, if not better than, that

Here a student trainee is using a device to measure and record the strength of small diameter wire.

of their male counterparts. For women, therefore, degrees beyond the bachelor's level are especially important. Advanced degrees together with research experience at the graduate level provide the best evidence of scientific competency.

IN HIGH SCHOOL

High school students who are attracted to a scientific career should consult their school counselor to determine college-entrance requirements and to make the proper selection of secondary school subjects. Preparation in high school is important both for college entrance and as the foundation for further study at undergraduate and graduate levels.

With the help of the high school counselor and college catalogs, girls who plan a career in the physical sciences can select subjects which will prepare them for college work. Good high school preparation includes two science courses (chemistry, physics, biology), at least 3 years of mathematics, and a background of study in English, foreign languages, and social studies. A course in technical drawing is also desirable. Although certain applicants may be admitted to college if their secondary education varies from this pattern, basic mathematics and science courses are essential to the student who intends to major in science.

School counselors can also help in the choice of a college, since they usually have ready access to information about many different schools. The individual student will probably want to consider a number of different colleges and apply for admission to several of them before making a final choice. Some colleges recommend that applications for admission be made before the beginning of the senior year in high school in order to obtain an early decision about admission. A college-board aptitude test may also be given by the college to promising students. If the results are satisfactory, admission then depends upon the high school record. Since some colleges limit the number of students admitted to the first-year class, only students with better-than-average records and recommendations may be accepted.

IN COLLEGE

College programs for the bachelor's degree in science vary somewhat, depending largely upon the science major selected by the individual student. Considerable overlap exists among the various sciences, and in recent years new fields have developed which combine branches of two or more sciences, astrophysics, for example, and geo-

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physics. Because scientists are increasingly using knowledge gained from scientific fields outside their own specialty, it is generally recommended that undergraduate students obtain the broadest possible training in all branches of their chosen science and in related sciences. Common to all physical and biological sciences, however, is the need for a comprehensive grasp of mathematics and familiarity with laboratory routine. Basic courses in chemistry, physics, and biology are also generally prescribed.

The typical college curriculum in science calls for a total of some 120 semester hours for the 4 years of undergraduate study, of which one-fourth (about 30 semester hours) are concentrated in the branch of science chosen by the student as a major. Another fourth of the work is usually in related sciences and mathematics, while the remaining half includes English, foreign languages, history, and the social sciences.

Courses outside the physical and biological sciences are important not only for broadening the individual's cultural background but for practical considerations as well. Knowledge of foreign languages enables scientists to read foreign scientific literature and to work in other countries and also to fulfill requirements for graduate degrees. The social sciences are important in preparing them for possible future advancement to supervisory or administrative positions. Most important, however, is the mastery of English, which is a basic tool of all professional and scientific endeavor. Without it, scientists may find themselves handicapped by inability to communicate effectively. There is a critical need in most jobs for clear expression, not only in speaking but for proper preparation of scientific papers and reports. Therefore the value of a thorough grounding in English usage cannot be overemphasized.

Students who are preparing to teach science or mathematics in secondary schools are required to supplement their science studies with courses in education and with practice teaching in order to qualify for teaching certificates. With the assistance of a faculty adviser, these students select a curriculum which will meet teaching requirements in the particular field of their choice. Advancement for the secondary-school science teacher generally depends upon the acquisition of a master's degree.

The master's degree is often the minimum requirement for college or university teaching as well as for many research positions. Although some students succeed in qualifying for it through 1 year of full-time graduate work, many actually spend 2 years to complete the requirements.

The doctor's degree, which is preferred for college teaching and highly desirable if not necessary for advancement, usually requires at least 3 full years of university study beyond the baccalaureate. Many scientists take a longer time to obtain the doctorate by combining or alternating employment with formal education.

A clue to the demand and supply situation for new secondary-school teachers of general science, chemistry, and physics is provided in a study published by the National Education Association in 1959. In the areas covered by the study (30 States and the District of Columbia), the number of new college graduates prepared to teach physics was 54 percent below the number of new physics teachers hired by secondary schools in September 1958. The number prepared to teach general science was 38 percent below the number of new hires in that subject; the number prepared to teach chemistry was 22 percent below the corresponding demand. The study covered 2,984 new science teachers hired by secondary schools in September 1958. It showed that in order to fill positions for science teachers the schools had to find additional teachers from sources other than the new graduates.

Scholarships and Other Financial Aid

There are many ways in which the young woman interested in a science degree can obtain financial assistance or help herself by earning money outside school hours. Scholarships and other monetary aids are available from both public and private sources.

President Eisenhower in his legislative program for 1958 requested the Congress to authorize funds for the States for the improvement of instruction in sciences, mathematics, and foreign languages, for the identification and encouragement of able students, and for college fellowships and loans. In response to this request, the Congress passed the National Defense Education Act of 1958, which was signed by the President in September 1958.

A 1957 survey of business firms revealed that one-third of the companies employing more than 1,000 workers and one-seventh of those employing 1,000 or fewer workers award one or more scholarships annually. Fewer than half of the firms restrict the awards to employees or their children. Awards range from $300 to $1,000 a year, with the largest number at $500. Most of them are renewable if the student's grades are satisfactory. A majority of the firms have tuition-aid programs for employees attending school on their own time.

Most of them require that the courses be job-related and that the student attain a certain grade for the course. Some firms offer fellowships, and some grant funds for research projects.

Almost every college and university has funds for scholarships or loans to help the undergraduate student. Financial aid is also extensively available to graduate students in the sciences, and the best qualified students usually succeed in defraying the cost of education, most commonly through teaching assistantships.

Many local clubs affiliated with national women's organizations provide assistance to promising local students.

The summer months offer an opportunity for some college students to earn money and to gain work experience. Some universities and private companies employ promising science students in their laboratories and plants during the summer. Such work opportunities permit students to become familiar with scientific work, to benefit from association with the professional scientists who supervise their work, and to evaluate their aptitudes and interests in the field, as well as to earn money to help finance their education. The student may work as a laboratory assistant, a computer aide, a statistical clerk, an aide in a museum, a nature counselor at a summer camp, or a helper in a greenhouse or on a scientifically operated farm, to mention just a few job possibilities.

The Federal Government also has inaugurated a program that permits many of its agencies to hire high school and college students for successive summers throughout their course of study. These student assistants or trainees are assigned to jobs in their field of vocational interest, under the guidance of experienced professional and technical personnel.

Extracurricular Interests

A number of study programs for high school science students are offered by universities and other organizations during the summer months. For example, one university runs a 2-week summer session for 80 high school pupils from the 9th through the 12th grades. Students take part in laboratory and field activities in the natural sciences. Another program provides for a 10-week summer session limited to 25 promising students who have had at least one course in biology. Research techniques and methods are taught. Cooperative work-training and apprentice activities for students are provided for by some local community groups during the summer months.

A young researcher examines the microscopic structure of a mounted uranium specimen on the metallograph.

Among other activities of interest to science students are science clubs, bird or wild-life study, amateur radio stations, scientific journals or books, and visits with scientists. Visits to laboratories, State extension stations, observatories, weather stations, museums of natural history and technology, and to scientific departments of all kinds are another instructive type of activity for prospective scientists.

The high school girl who is interested in science may become a member of one of the Science Clubs of America, affiliated with Science Service, Inc. In 1959, there were nearly 25,000 such clubs. If none is available in the community, a club can be organized by a sponsor or teacher in any grade who requests material from headquarters. Information about such organizations can be obtained from the Science Clubs of America, 1719 N Street, NW., Washington 6, D.C. Science Service, Inc., of the same address, is the parent organization, a nonprofit organization which sponsors science fairs for high school students. The students develop science projects which are displayed at these fairs. Scholarships, prizes, and trips are awarded to the winners. Outstanding projects are sent on to a national fair. Finalists may receive additional awards. A Science Talent Search is also open each year to all high school seniors. Winners are awarded scholarships. Any high school principal or teacher may request copies of the examination by writing to Science Talent Search at the address given above.

The program of the Future Scientists of America Foundation (of the National Science Teachers Association), with headquarters at 1201 16th Street, NW., Washington 6, D.C., is another activity for high school students interested in science. This organization sponsors an annual contest, known as the Science Achievement Awards, in which science students in junior or senior high schools all over the country enter their science projects. In 1957, over 30,000 boys and girls entered the contest, and 2,941 submitted completed projects. A judging team of science teachers and scientists chose the 140 winners, who were awarded United States savings bonds in denominations ranging from $25 to $100, paid for by the American Society for Metals. In addition to those receiving the bonds, some entrants were awarded honorable-mention certificates. That girls as well as boys are successful in this program is indicated by the fact that 28 of the 140 winners in 1957 were girls. Of the 20 highest award winners, who received $100 savings bonds, 7 were girls. The current year's program (1959) included 220 such awards, totaling about $14,000. Reports of the projects, written by the students themselves, are published in a magazine entitled "Tomorrow's Scientists."

Finding Employment

Many employers send representatives directly to college campuses to recruit scientific talent. Interviews with prospective graduates, both men and women, are arranged under the supervision of college authorities. Frequently, students have positions awaiting them upon graduation.

Professional societies, college placement bureaus, and individual faculty members receive many requests for names of science graduates; and, of course, applications for employment may be made directly to personnel offices of large companies employing scientists. Those interested in working for the Federal Government may apply at the nearest office of the U.S. Civil Service Commission. (Any post office can supply a list of such offices.) The prospective science teacher may apply directly to the school of her choice.

State Employment Service offices, affiliated with the U.S. Employment Service, provide placement services for professional and technical workers without charge to the applicant. Information about these services may be obtained through local public employment offices.

Of a sample representing nearly 600 employed women chemists who had received their bachelor's degrees in June 1957, surveyed about 6 months later by the Women's Bureau and the National Vocational Guidance Association (N.V.G.A.), 50 percent reported that they had found their jobs through their college placement bureau or college professor; 36 percent, through direct application; 6 percent, through newspaper advertisements; 5 percent, through private employment agencies; and 2 percent, through family or friends.

Earnings and Other Work Factors

HOURS

For most scientists in both government and industry, the 40-hour week is standard. In teaching, although actual classroom hours may be shorter and vacations longer, preparation for lectures and keeping up with current scientific developments consume additional time. In research, field assignments may involve irregular hours and varied locations.

EARNINGS AND OTHER BENEFITS

Salaries have been advancing rapidly for most scientists, both men and women. It is expected that earnings, along with prestige, will continue to rise with the emphasis on the Nation's need for scientific progress.

According to the survey of women college graduates mentioned earlier, the best starting salaries for women graduated in June 1957 were received by those with physical science majors. For a sample representing 970 women with a bachelor's degree in a physical science, the average annual salary 6 months after graduation was $4,509.

For the entire study, representing some 64,000 employed women graduates, the average was $3,739.

The Federal Government has gradually raised entrance salaries in various science classifications in order to attract more scientists to Government service. By mid-1958, the entry salary for Federal Government scientists (men and women) without work experience was $4,490 in grade GS-5 in astronomy, chemistry, geology, meteorology, and physics. The starting rate of $4,490 was above that for professional workers in most other fields. Furthermore, the Federal Departments are authorized to hire beginning college graduates in certain fields at almost a thousand dollars more a year (grade GS-7) if their college records indicate superior qualifications.

In general, the minimum required by the Federal Government for its beginning scientists is a college degree with a major in the appropriate science; or an equivalent 4 years of progressive, professional experience; or some combination of both. Higher salaries commensurate with higher grades are provided for additional experience or graduate training. In 1954, the Federal Government paid women scientists an average of $5,541 in physics, $5,426 in astronomy, $5,067 in chemistry, $4,937 in geology, and $4,749 in meteorology. As a result of a salary increase of 7.5 percent, put into effect in 1955, and another increase of 10 percent 2½ years later, these average salaries were about $1,000 higher in 1958.

College science professors and persons with considerable experience in the Federal Government may attain salary levels of $15,000 or more, while scientists in high administrative posts in industry may receive as much as $50,000 a year. Although not many women scientists have advanced to top executive positions up to the present, it is interesting to note that a few women have achieved such distinction.

Many companies, especially the larger industrial firms, offer financial incentives in the form of tuition aid to encourage their employees to take graduate training if they have not already done so, or to take special courses on new developments in their field.

In addition to the tangible benefits of relatively high starting salaries and possible future advancement, careers in the sciences offer most professionals a personal satisfaction in their work, a chance to learn and keep up with the latest discoveries in the field, and an opportunity to develop their highest capabilities. The scientist's own awareness that her work is useful to society is heightened by the recognition and prestige accorded by the community.

Chemistry

Chemistry, the largest of all fields in the physical sciences, employs more women than any other of the scientific fields covered in this report. It is estimated that in 1958 there were about 120,000 chemists in the country, of whom some 12,000 were women.

Chemistry has been described as the science that deals with the composition of substances and their physical and chemical transformation; the way they react to each other; the chemical processes required to obtain them from nature or produce them synthetically; and the ways in which they can be put to practical use.

Specialties in Chemistry

Because of the vast scope of this science, chemists usually specialize in one of its five main branches; namely, organic, inorganic, physical, or analytical chemistry; or biochemistry. Furthermore, they often specialize in a subdivision of one of those branches, such as spectroscopy, ceramics, detergents, atomic and nuclear structure, food chemistry, or pharmaceutical chemistry. A brief description of the specialties in the field of chemistry as summed up in the Occupational Outlook Handbook follows:

Organic chemists usually deal with carbon compounds—substances derived chiefly from animal and vegetable matter. Inorganic chemists are concerned chiefly with compounds of minerals and metals, but they may also work with a few substances containing carbon, such as carbonates and carbides. Physical chemists study the quantitative relationships between the chemical and physical properties of both organic and inorganic substances; for example, how these substances are affected by electricity, pressure, heat, and light. Analytical chemists determine the exact chemical composition of substances, thereby providing controls for all types of chemical operations. Biochemists are concerned with such chemical reactions as occur in plants and

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This scientist, now studying for a Ph. D. degree in physical nuclear chemistry, helped in developing the world's first atomic powered submarine.

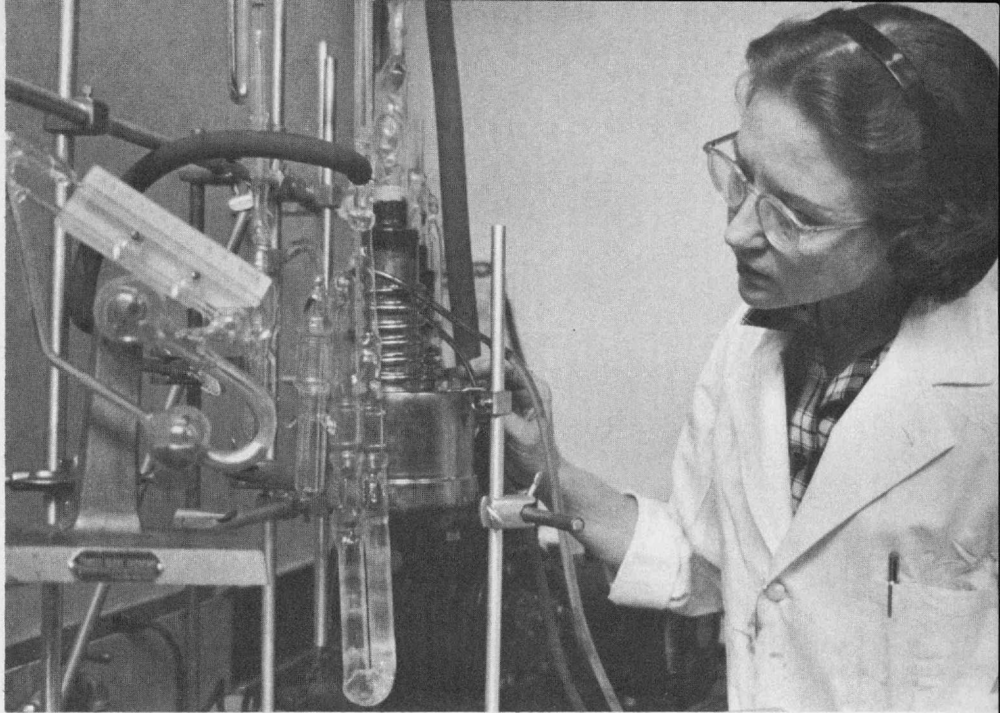
animals (for example, the effects of food or chemicals on plant and animal tissues) and with the influence of chemicals on life processes.

Some chemists specialize in a particular industry or product, such as cosmetics or fibers. Such specialization in many instances requires a knowledge of more than one branch of chemistry.

Women in Chemistry

A large proportion of women chemists are employed in private industry. Of those who responded to the National Register of Scientific and Technical Personnel, some 40 percent were in private industry; almost as many were employed in the higher education field; and the remaining 22 percent were divided about equally between government and nonprofit foundations. More than one-half of those who held a Ph. D., however, were in colleges and universities where they were engaged in both teaching and research.

Nearly half of the women chemists on the 1954–55 Register reported research as their primary activity, and about one-fifth reported



Women chemists work in a wide variety of activities. This one specializes in solid propellant rocketry for a research and development company.

teaching. Most of the remainder reported either inspection or technical writing. (Table 5C, page 65.) A 1955 survey by the American Chemical Society indicated that about half of the women chemists who were engaged in research were working on the development of new and improved products and processes, while the remaining half were working in basic research.

An association of companies in chemical processing reported in 1956 that the proportion of women on their chemical research staffs was increasing. Almost half of the research staff of a leading cosmetics company, and one-tenth of the research staff of a large pharmaceutical firm were women. Women chemists were also reported employed as chemical analysts, technical writers, and technical librarians in the chemical-processing industry. Many women chemists have successful careers in these pursuits.

Government agencies—Federal, State, and local—are large employers of women chemists, also. In 1954, more than 550 women chemists worked for the Federal Government. This was 12 percent of all chemists in the Government. About one-third were employed in the Washington, D.C., metropolitan area.

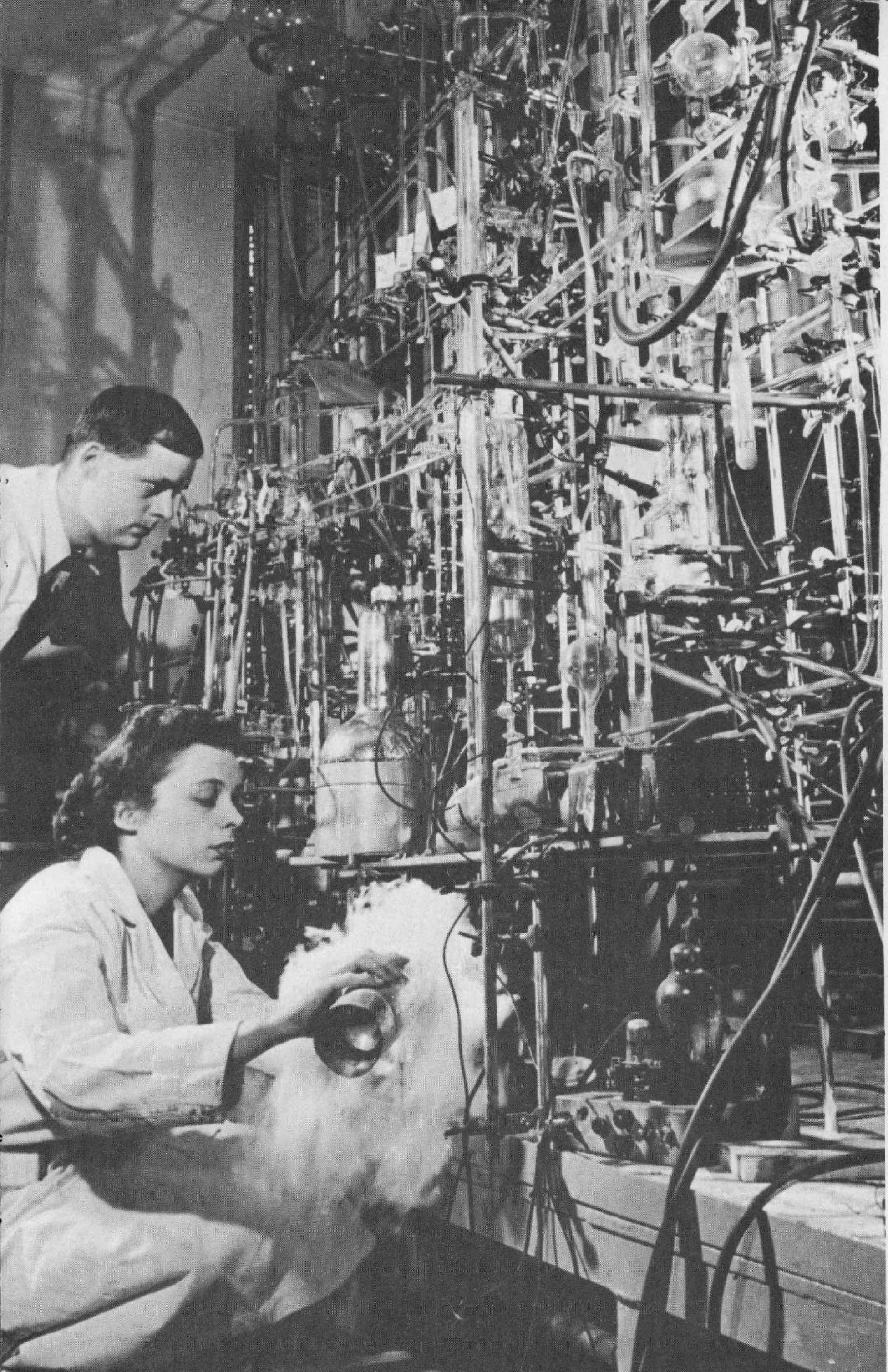
A fog of condensed air rises as a woman scientist, studying the reaction by which gasoline is made from coal, fills a flask with liquid nitrogen.

One Federal agency which employs a large number of chemists, many of them women, is the Department of Defense, which carries on scientific research, including research in medicine. Research chemists in the Department of Health, Education, and Welfare investigate medical problems connected with the Public Health Service program or perform functions related to the enforcement of the pure food and drug laws by the Food and Drug Administration. The Department of Agriculture employs a number of biochemists for such projects as the development of techniques for processing foods without the loss of valuable food elements. Other Federal agencies employing some women chemists include the Department of Interior, the National Bureau of Standards in the Department of Commerce, and the Veterans' Administration.

Women chemists have gained recognition in a wide variety of activities in private industry, as evidenced by the large number of articles published in newspapers, magazines, and other periodicals. A few of their stories follow.

- A woman biochemist with a Ph. D. degree became the head of the nutrition department of a research institute. She has also taught at various colleges and has been specializing in amino acids and in B-complex and E vitamins.

- Another outstanding woman biochemist with a Ph. D. degree became vice president and director of a large flour-milling company in 1947. After receiving her bachelor's degree, she entered the employ of the company as a chemist and advanced to her present level. She has specialized in the chemistry of wheat and flour and fermentation processes and has been awarded a number of medals for excellence in her work.



- One young woman chemist working in a leading radiation laboratory recently developed a smoke from plastic bubbles, which she named "holey smoke." It has possible uses as a shield against polluted air from experimental nuclear blasts as well as for smoke screens and sky writing.

- While working on antibiotics in a large research laboratory in the Chicago area, a woman chemist discovered a drug that greatly inhibits bacterial growth. This woman, holder of a master's degree, said that her discovery was the result of 2 years of patient testing.

- One of the most outstanding women chemists in the country, a college teacher, was awarded the Nobel Prize in 1947. Born in Prague, she obtained her degree as a physician there. Later she entered Washington University, St. Louis, Mo., as a research assistant in the School of Medicine and advanced to the rank of professor in biochemistry. She became a naturalized citizen of this country and received many awards and medals for her work on sugar and lactic acid, the metabolism of tumors, the mechanism of insulin action, and blood formation in the liver.

Earnings and Other Work Factors

The American Chemical Society has reported that the median entry salary, countrywide, for inexperienced women chemists with the bachelor's degree, surveyed in 1958, was $374 a month—somewhat lower than the $400 reported in 1957. However, some of the beginning salaries for women chemists were as high as $485 a month in 1958. An earlier survey (1955) showed that monthly salary rates increased with length of experience. For example, women chemists with 2 years of experience had a median salary of $367; those with 4 years, $390; those with 8 years, $416. Half of the women who were in the field for 15½ years earned at least $465 a month, and the top 10 percent earned $670 or more.

Salaries for chemists have been rising over the past 15 years, and it is expected that this trend will continue. Average salaries of men chemists are reported to be higher than those of women chemists. In 1955, salaries of men with 15½ to 34 years of experience who were members of the American Chemical Society averaged over one and one-half times those of women members with corresponding years of experience. A number of factors account for this differential, however. For example, a much smaller proportion of women chemists than men worked in private industry, which has comparatively high salary levels. About 25 percent of the women were employed by teaching institutions, but less than 15 percent of the men were so employed. Also, since men are likely to have more graduate training than women, their salaries tend to be higher. The American Chemical Society report showed that about 40 percent of the men, but only 26 percent of the women, had earned the doctor's degree.

Standard hours of work are generally scheduled in chemical laboratories except where extended observation of experiments is involved. Various safety measures have been built in to laboratory procedures to minimize hazards of handling explosives, acids, and other dangerous substances.

Job Possibilities

Because holders of the bachelor's degree greatly outnumber those with graduate degrees, much of the recruitment of chemists will continue to be directed toward the new graduate with a bachelor's degree in chemistry. Persons with graduate degrees, however, are in very great demand, and companies have been emphasizing this in their hiring policies. First jobs for those with an undergraduate degree are often in analysis and testing. Some enter the teaching field, and still others find jobs as technical writers.

Relatively more positions in research and in college teaching are open to beginning chemists with the master's degree than to those without graduate training. Much of the basic research, as well as the high-level applied research and development in industry, is reserved for holders of the Ph.D. degree.

Students may wish to consult the American Chemical Society (1155 16th St., NW., Washington 6, D.C.) for further information that might be helpful in planning a specific career. The Society publishes a variety of informational materials.

This physicist with the National Bureau of Standards is assembling an experimental furnace for use in high-temperature thermocouple research.

Physics

The science of physics is concerned with energy in all its forms, with the interrelations of matter and energy, and with the structure of matter.

The wonders of the modern world—electronic computers, radar, solar-powered electricity, television, atomic and hydrogen bombs, supersonic jet planes—all these are technological developments based in part on the theories formulated by physicists. Some of the significant changes which have occurred in this profession during recent years are indicated by the extensive employment of physicists in private industry today. Formerly employed largely in classrooms and university laboratories, physicists have within the past decade or so gone into the laboratories of business and government in the same way that chemists did during and after World War I.

Demand for Physicists

Estimates developed for 1958 indicate a total of roughly 30,000 physicists, of whom about 900 were women. The majority of women physicists are principally employed by colleges and universities in the teaching profession, with some in research. (See chapter on "Characteristics of Women Physicists on the National Register of Scientific and Technical Personnel" table 7A, page 69.)

The demand for well-qualified physicists exceeds the supply, and the need is growing at an increasing rate not only in the newer areas associated with nuclear energy and radar, but also in the older fields—especially in optics and acoustics. Those with advanced training are in greatest demand.

Most physicists will find a doctoral degree essential to attain a full professorship, or to teach advanced and specialized courses. The most responsible jobs on research projects conducted by educational institutions are usually reserved for holders of the doc-

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torate, although physicists at all educational levels are employed on the projects. Physicists with the master's degree who are engaged in teaching are assigned mainly to undergraduate courses in general physics. High-caliber graduate students with the bachelor's degree in physics frequently are employed as teaching assistants—conducting laboratory sessions or teaching elementary courses.

Specialties in Physics

The great majority of physicists, both men and women, are engaged in research or in college teaching. As described in the Occupational Outlook Handbook, the research may be basic (that is, directed to studying fundamental physical laws without regard to practical application), or it may be applied (that is, directed to the solution of an immediate, specific problem, as for example, investigating the behavior of solid materials under stress, in order to find suitable uses for new plastics). Some physicists add to basic knowledge through careful and systematic observations and experiments on identifying and measuring matter and energy and their interaction. Others integrate these findings into a theory or system of equations which describe their interrelationships. The physicist doing theoretical research frequently guides experiments and interprets the results, while the experimental physicist is concerned with testing the theory.

Physicists doing applied research, probably the majority in this field, use equipment such as spectrographs, X-ray and electron-diffraction cameras, Geiger counters, phase and electron microscopes, oscillographs, and vibrometers. These instruments extend enormously the range of the senses. Thus, photocells permit ready identification of colors which are beyond the eye's capacity to distinguish, while ultrasonic detectors facilitate the recording of sounds beyond the normal hearing ability of the ear.

Large numbers of men and women physicists are employed in private industry. Many are concentrated in laboratories, performing research and development work. Some, however, work in production plants or administrative offices in a management capacity (determining research policies and administering research laboratories) or as production assistants, designers, or inspectors.

Some physicists in industry use their ideas and their theoretical knowledge to create final products. These scientists, in applied research, plan and conduct experiments; they often supervise the preparation and testing of laboratory models and, later, the design and testing of working models. The physicists may investigate, for example, an acoustical problem—for manufacturers of loudspeakers and sound recorders; a visual problem on light, spectroscopy, and colorimetry—for optical and photographic equipment manufacturers; or they may work with chemists on a problem such as the protection of woolens against shrinkage.

Industrial laboratories have in recent years shown a great deal of interest in physicists trained both in research and in engineering. As a result, a number of universities now offer a combination curriculum in physics and engineering. At least five have established a special 5-year training program leading to the degree of Bachelor of Engineering Physics.

The Federal Government utilizes the various branches of physics in its research and development work. Physicists in the government are engaged not only in research (largely applied) but also in related activities such as administration and scientific and technical writing. They are among those responsible for progress in such fields as aeronautics and atomic energy. In the Department of Defense, they may work in various laboratories such as those at Aberdeen Proving Ground and the Wright-Patterson Air Force Laboratories. They work on a wide variety of problems including those related to supersonic and high-altitude flight, physics of the ocean, detection of submarines and protection against torpedoes, and the physics of explosives, both chemical and nuclear.

In the National Bureau of Standards of the Department of Commerce (where standards of measurement for the United States are developed and maintained), physicists may work on such assignments as the determination of capacity, internal resistance, and voltage drop of storage batteries; examination of photographed spectra with microphotometer and micrometer comparator; or computations in optical designs involving ray tracing.

The Department of Agriculture has recently utilized physicists in some aspects of its research programs. One function of physicists in this agency is the assembly and operation of test equipment for measuring certain properties of natural and synthetic substances.

Much of the work in nuclear physics is carried on by industrial concerns and universities under contract to the Atomic Energy Commission, which administers manifold research activities. As a result, many jobs in this specialty are with private laboratories rather than with the Commission. Each of the laboratories has its own research and development program and offers extensive opportunities for pioneering work in physics.

Because certain types of activity in nuclear physics and radiation work may infrequently be hazardous, special precautions and safeguards are provided. Available safety records indicate that job-related illnesses and accident rates to date have been quite low.

Women Physicists

Most of the research in colleges and universities which is conducted by women physicists with a bachelor's degree is applied or develop-

Here a physicist is measuring the radioactivity in the thyroid gland of a patient who has been given an "atomic cocktail."

This physicist is operating a "Pellat Balance" which weighs the force produced by an electric current. She must work from another room to avoid air disturbance.

mental, rather than basic or fundamental. As part of their training, these physicists assist senior staff members (usually with Ph. D.'s) by carrying out experiments, setting up and operating laboratory apparatus, making advanced computations, recording and accumulating data and assisting in their analysis, or performing such production-related activities as design and inspection. They may also conduct library research before initiating laboratory investigations or direct the work of technical laboratory assistants who make routine physical tests.

The contributions of women physicists in institutions of higher learning are evident from the following examples:

- One woman physicist with a doctorate, who is a professor at an outstanding university, specializes in the study of the standardization of X-ray and radium dosage, the biological effects of radiation, and the application of X-rays, radium, and isotopes to medicine. Earlier, she taught in various high schools, then became assistant physicist in a New York hospital and, later, a radiophysicist in an eastern university. She has received medals of achievement from the Roentgen Ray Society, the International Women's Exposition, and other organizations.

▶ Another woman physicist, who entered graduate school in the city where her husband was doing graduate work, specialized in solid-state physics. She won 1 of the 38 first-year fellowships of the National Science Foundation and won another scholarship for her second year of graduate work. For the third year, she was awarded a teaching fellowship. She and her husband plan to combine teaching and research at a small college or a university.

▶ A husband-wife team of physicists doing research and teaching at a university worked with a group on the discovery of heavier-than-hydrogen nuclei in cosmic rays. The wife, who worked part time while raising a family, has written articles for publication on the research of the group.

▶ An internationally known woman physicist was one of the several scientists who spent long years in research that led to the atomic age. Born in Austria in 1878, she studied in Europe and became a professor at a famous institute in Berlin. There, she received acclaim for her work on the products of disintegration of radium, thorium, actinium; on the behavior of beta rays; and on the physics of the atomic nucleus. Leaving Germany at the time of Hitler, she went to Sweden, where she continued research on important clues in the release of atomic energy. Her findings have been compared to those of the world-famous scientist, Marie Curie, codiscoverer of radium. With colleagues she discovered protoactinium. During an experiment she and a coworker noticed the unexpected appearance of barium, and from this discovery she deduced mathematically that it indicated the fission of the uranium atom.

Only a relatively small proportion of women physicists are employed by private industry, but their numbers are expected to grow as the demands of industry for scientists in general increase and as the principles of physics are applied to new problems in this field as well as in biology, chemistry, and geology. Companies employing women physicists range in size from small, independent consulting laboratories performing research on a contract basis for firms in different industries to giant industrial corporations. Women physicists are found working in the telephone industry; radio and television broadcasting fields; and in industries manufacturing communications and electrical equipment, scientific instruments and photographic apparatus, machinery and transportation equipment, and miscellaneous products such as petroleum, glass, rubber, and chemicals. An illustration follows:

▶ A young woman physicist with the master's degree is employed by a California company that produces nuclear reactors. She is responsible for setting up new reactors at various places throughout the country and testing them to determine whether they are functioning properly. Previously, she worked with the National Bureau of Standards and with the Air Force.

More than 100 women physicists were employed by the Federal Government in 1954. These women constituted 4 percent of all physicists in Government employ. About half of them were working in the Washington, D.C., area.

- A woman physicist who works for the Atomic Energy Commission at the Oak Ridge National Laboratory does pioneer research with mice to discover the effects of radiation on embryonic development. In 1955, she published seven scientific papers, some in collaboration with her husband. She has participated in several scientific conferences and was chosen to present a paper at the first International Conference on the Peaceful Uses of Atomic Energy.

The National Bureau of Standards in the U.S. Department of Commerce employs a number of women physicists:

- One, a specialist in acoustics, has recently been awarded a Government medal for meritorious service. A member of the Sound Section of the Bureau, she deals with speech-communications systems, analysis of transients, and problems associated with the measurement of hearing. She has an M.S. degree in physics and has taken additional graduate work in several universities. She worked as an astronomer with the U.S. Naval Observatory before entering the Bureau of Standards. In addition to being author of numerous publications she is a co-holder of a pending patent in her field.

- A second is engaged in research and specializes in the elastic scattering of high-energy X-rays to determine nuclear processes. Before working for the U.S. Government, she was employed as a physicist at a university radiation laboratory. She has earned her doctorate in her chosen field and is the author of a number of technical papers. She and her husband, who is also employed at the Bureau, share scientific interests.

Other examples of research papers and new developments in the field of physics can be found in the various journals published by the American Institute of Physics (335 E. 45th St., New York 22, N.Y.)

With scientific knowledge continually being increased, newly created areas of study give rise to further careers in physics in a multitude of specializations, including some newer fields, such as aeronautics and space physics. Moreover, the rapidly increasing importance of physics in modern-day industry can be expected to result in enlarged employment opportunities for women physicists.

Geology

One of the reasons for the strength and growth of the United States is its wealth of mineral and fuel deposits. The geologist is a specialist in the search for these raw materials and, therefore, plays a fundamental role in advancing our industrial economy. In addition to these practical applications, geologists are absorbed in studying the structure of the earth and how it has been changing.

Specialties in Geology

Geology has been described as the science which is concerned with the study of rocks and with the earth's history as revealed by rock formations and fossil remains of animals and plants from past geologic periods. The majority of scientists in this field are petroleum geologists, a special group concerned with locating and developing fuel resources. Others, engineering geologists, apply their knowledge to engineering problems, such as those involved in highway construction or in the choice of suitable sites for bridges and dams. Many similar problems are encountered by military geologists in analyzing terrain and planning military strategy. With undersurface water becoming increasingly scarce to both city dwellers and industrial users, groundwater geologists make valuable contributions through their work on the sources, distribution, and quality of water.

There are specialists in a number of other major branches of the science of geology. Petrologists deal with the natural history of rocks, their origin, composition, present condition, and decay. In this field are stratigraphers, who study the relationships and chronological sequence of rock layers. Paleontologists specialize in fossil identification and classification. Mineralogists, including geochemists, specialize in the classification, composition, and structure of minerals. Structural geologists are interested in the formation and deformation of the earth's crust through folding and breaking. Geomorphologists are concerned with land forms and causes of surface alterations. Geologic mappers record information on maps, often by aerial photographs through photogeologic methods.

Women Geologists at Work

Estimates for 1958 place the total number of geologists, exclusive of geophysicists, at some 14,000, of whom more than 400 were women. A number of these women have been in this occupation for some time and have achieved recognition for distinguished work. Opportunities for women are less varied than for men, however, since many jobs require a considerable amount of time to be spent in field exploration. For example, men geologists can find entry jobs as field assistants, but few women geologists start their careers in this type of work.

The women who have successfully adjusted to the rigorous nature of the work, extensive travel, and irregular hours may serve to encourage employers to offer greater opportunities to women geologists in the future.

Women geologists on the National Register of Scientific and Technical Personnel (1954–55) were employed mainly by private industry and government (with private industry employing a few more than government). A small group were employed by colleges and universities; and a few, by foundations. The majority were engaged in research; some in government did technical writing; and most of those in colleges were teaching. (For additional detail see chapter on Women Scientists on the National Register of Scientific and Technical Personnel.)

Field activities involve exploring the surface and subsurface of an area to analyze its structure and rock or mineral content; studying fossil remains of vegetable and animal life; recording data from the observations and measurements, and drawing working maps; and collecting specimens for subsequent laboratory study.

A few women have established high reputations in field work for individual companies.

▶ One of these women, who is married and has a Ph. D. degree, was hired as a consultant to a major oil company to explore for oil. Preferring this to desk work, she walked 10 to 15 miles a day on a recent African trip, carrying almost 50 pounds of equipment and cooking her own meals. She sent rock specimens home and upon her return examined the samples for oil-bearing indications. Her work in paleontology is considered a valuable contribution to the science by the American Association of Petroleum Geologists.

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Positions that women secure most readily are in laboratory work in government and industry (principally petroleum and natural gas), in museums, in library research in the mining industry, in technical writing for scientific journals and popular magazines, and in administrative work as assistants to geologists in executive positions. Some who are particularly well qualified may obtain teaching jobs in colleges and universities; they combine formal classroom instruction with field trips and, in addition, often engage in other activities such as consulting, administrative work, research, or writing.

One type of job open to women geologists in industry involves the microscopic examination of oil-well samples in the laboratories of petroleum companies. Women also perform a variety of chemical and physical tests to identify the different types of rocks and determine their age or composition. This identification helps to form the basis for decisions as to where to drill or tunnel for purposes of locating oil deposits and extending those already discovered or abandoning them when they appear to be unprofitable. Other duties may include evaluation of field observations, computation of probable locations of subsurface strata, and assistance in map preparation.

In the long run, more personnel will be needed for extensive research and analysis of geological specimens and other data. This is in part because the search for new mineral resources is becoming intensified, and in part because the Federal Government is mapping geologically additional areas of the United States. One Government agency, the National Park Service of the U.S. Department of the Interior, engages geologists to do research on local geological features as well as to give lectures to tourists on the geology of national parks. Other agencies conduct geological surveys of certain districts to study underground water supplies or conditions leading to soil erosion, to locate and define the limits of mineral reserves, and to plan the conservation and development of certain natural resources. Among such agencies are the Geological Survey and the Bureau of Reclamation of the Department of the Interior, the U.S. Army Corps of Engineers, the Atomic Energy Commission, and the Soil Conservation Service of the Department of Agriculture. Similar duties are performed by geologists employed by various States.

Successful experience in field work is usually required for advancement to research, administrative, executive, and consulting positions. Even though the need for geologists is expected to increase in the future, women whose field experience is limited will find advanced degrees especially important in competing for such positions.

The Geological Survey also hires women as geologists or scientific aides who supervise certain office functions and thus free higher-level

The majority of scientists in this field are petroleum geologists. This one examines oil-well samples in the laboratory of a large petroleum company.

geologists of many details. They handle personnel and minor administrative matters, write letters, answer inquiries, assist with publications and exhibits, and receive visitors in the absence of their superior officers. Their duties require the training of a geologist, since they have to make decisions which require a technical knowledge of the projects under consideration.

A high proportion of the women geologists with a doctor's degree in the employ of the United States Geological Survey have had previous experience in the educational field, usually as teachers.

▶ One has been employed as a paleontologist, specializing in the mollusks (clams, oysters, etc.) of the Atlantic and gulf coasts and northern Mexico. Another has done work on the Precambrian formations of certain sections in New York State and Arizona.

Colleges and universities are a source of employment for a small number of women geologists. Teaching positions in this field generally exist in departments of geology but are also found in engineering departments and in schools offering mining, metallurgical, or similar programs which require instruction in the earth sciences. Such programs tend to be concentrated in States where oil and mineral extraction are an important part of local industry and which consequently have built up departments specializing in the economic aspects of geology. Persons possessing doctorates are given preference, although a number with less advanced education assist with the instruction. Some work for higher degrees while teaching, and others have fellowships and assistantships which provide them free tuition in return for teaching services.

In addition to teaching, faculty members often conduct research, for example, on such questions as the course of an ancient glacier. Sometimes they engage in industrial research problems such as the selection and location of a clay deposit for a pottery manufacturer. They may also serve as consultants to government agencies, especially during their summer vacations. Important research has been accomplished by these teacher-scientists.

▶ For example, a woman geologist teaching regularly in a university has added greatly to existing knowledge of the various kinds of rocks. Her earlier experience was as a demonstrator in the laboratory of the college where she obtained her Ph. D. degree; as a paleontologist in a nationally known museum; and as a specialist with the Geological Survey, where she worked in the fields of petrology and stratigraphy.

Staffs of large natural-history museums usually include geologists. They set up exhibits and work with the identification and classification of specimens. Some are also called upon to give public lectures.

A number of women find employment as technical librarians. Training or experience in library work is desirable, and a thorough grounding in geology is necessary for such work.

Another field in which women geologists may be employed is that of technical editing. In addition to training in geology, a technical editor needs a good knowledge of English usage. Courses in journalism are useful but not essential, provided the geologist can present material in a clear and interesting form. Some acquaintance with printing operations is helpful.

Preparation

Certain personal traits and interests are important for a career in geology, especially for field work. It would be desirable for students considering such a vocation to like camping and outdoor work, to be interested in travel, and to possess the ability to take a certain amount of physical hardship in stride. They must also be adaptable to life at high altitudes, in desert areas, and under varying conditions in inaccessible areas of the United States and foreign countries and must be able to work as part of a team. However, these characteristics may not be as important in laboratory research, teaching, and writing as in field research.

In geology, as in other sciences, there has been increasing emphasis on graduate training as the science has grown in complexity. Nevertheless, a survey made several years ago showed that a substantial proportion of the petroleum and natural-gas geologists—the largest group in this science—were holders of the bachelor's degree. Geologists with doctorates have proportionately greater representation in the other fields of specialization, as well as the prospect of higher salaries and full professional status. Graduate work is extremely important to the small number specializing chiefly in college teaching and research.

In addition to comprehensive training in the various divisions of geology, a knowledge of other sciences—such as physics and chemistry; engineering and mathematics; or botany and zoology—is desirable for geologists. They may broaden their background still further through field, laboratory, and office experience. (Some jobs, however, particularly those held by women, are almost exclusively in laboratories). Thus, geologists must be grounded in the techniques of surveying, map making, note taking, and specimen collecting, as well as in laboratory procedure for identification and analysis of geologic specimens.

There are relatively few colleges and universities that grant the bachelor's degree in geology—199 in the academic year 1957–58.

There were still fewer awarding graduate degrees in geology: approximately 89 schools granted the master's degree; and 34, the Ph. D. The largest number of undergraduate degrees in this science were conferred by five institutions in the South and West, although schools in all parts of the country were represented. On the other hand, the largest number of Ph. D.'s were granted by five schools in widely separated States—New York, Illinois, Wisconsin, New Jersey, and Connecticut.

Bachelor's degrees in geology are awarded in colleges of arts and sciences and in some engineering schools offering a major in petroleum engineering or petroleum geology. In addition to the usual courses taken by most science students, those majoring in geology enroll in courses covering all aspects of this field. "Tool" courses such as surveying and engineering drawing are also essential.

Since attainment of these degrees generally requires a reading knowledge of one or more foreign languages, students planning to study for advanced degrees should at an early stage investigate basic language requirements for the master's or doctor's degree. One geology professor reports that research institutes are asking for women trained in science who have a reading knowlege of one or more modern languages.

For further information on developments in the field of geology, students may wish to consult the American Geological Institute (2101 Constitution Ave., NW., Washington 5, D.C.).

Earnings and Hours of Work

The highest salaries for geologists are usually paid by private industry. In 1956, salaries for beginners without experience were reported at $425 a month. After 10 years of experience, the monthly salary averaged about $600 for all geologists but only $500 for women.

College geology teachers were paid from $250 to $750 a month, depending upon experience, educational background, and type of position. Most teachers are free during summer vacations to do research, to study, or to supplement their income by counseling work, writing books or articles, or participating in explorations.

Average earnings for some 100 women geologists who worked in the Federal Government in 1954 were $4,937 a year. Since then, salary rates have twice been increased; the entrance salary for beginning geologists was set at $4,490 in 1958.

Hours of work in offices and laboratories are the usual 40 or less a week; for those engaged in field work, hours may be very irregular.

Astronomy

Exciting discoveries await astronomers—those explorers who seek to unlock the mysteries of the universe. In this era of the race toward the moon and the planets, the importance of the science of astronomy overshadows the fact that this field engages only a few hundred astronomers, the smallest group among scientists.

It has been estimated that in 1958 there were some 500 astronomers in the country, of whom at least 75 were women. Though the actual number of women astronomers is small, they are well represented in this profession where they constitute roughly 15 percent of the total, which is a higher proportion than in any other of the scientific fields covered in this study.

Importance of Astronomy

While "star gazing" may be said to be an occupational disease with them, astronomers are in fact "down-to-earth" researchers who make time-consuming observations and calculations on the nature and composition of the universe. They study the size, shape, luminosity, position, composition, characteristics, structure, temperature, distance, motion, and orbits of celestial bodies in an ever-changing universe. They are interested in eclipses and comets; in the classification, measurements, and evolution of stars; in star clusters and nebulae, as well as in the fascinating question of the possibility of life in other worlds.

Because of the current emphasis on the possibility of space travel, attention has recently been focused on the moon and the planets nearest the earth. A growing body of knowledge has also been accumulating from analysis of the radiation from these bodies. Recent astronomical discoveries have been made possible by improved instruments and techniques, including certain light-measuring devices, optical equipment such as radiotelescopes, and complex photographic methods.

Astronomy is today being used in a number of applied fields. Investigations which had been considered the domain of pure astronomical science—for example, meteors and the flow of planetary and stellar gases—are now used in ballistics research and in the development of guided missiles and earth satellites. Consequently, the competence of astronomers in physics and mathematics is being increasingly used by government and industry. Only recently (early 1959) one of the private firms which is engaged primarily in space research hired a woman astronomer for its guidance and navigation department.

Mathematics and statistics have important practical applications in astronomy; for example, in the prediction of tides, the determination of the official time, and the preparation of almanacs and charts which enable air and marine navigators to determine by observation of sun, stars, and other celestial bodies their exact position on land or sea at any time. A new field, the analysis of the orbits of manmade satellites, has just been opened and is now inviting further research on related problems concerning the size and shape of the earth and the density of the upper atmosphere.

Some astronomers, called astrophysicists, apply the techniques of physics to astronomical problems. Radiation originating from distant bodies is closely examined, and interpretations are made concerning the age, temperature, luminosity, chemical composition, and internal structure of the object. The development of the radio telescope—an innovation which permits the observation of more remote space—is a recent breakthrough and illustrates the dynamic character of this science. Another specialized device, the spectrometer, separates light into a spectrum (a series of colors) and measures the individual wave lengths. Other measuring instruments include the photometer, which is concerned with intensity or brightness; and the bolometer, which measures minute quantities of radiant heat found in the spectrum. These instruments are attached to telescopes to provide a comprehensive description of the chemical composition, luminosity, and temperature of stars.

Observatories

Close to 300 observatories, buildings designed or adapted to house a permanently mounted telescope, are located in all but a handful of the States. Most of these observatories are relatively small. Among the most famous large observatories are the Mt. Wilson, Mt. Palomar, Harvard, Lick, Yerkes, and McDonald Observatories. The Federal Government operates the U.S. Naval Observatory and the Astrophysical Observatory of the Smithsonian Institution. A new observatory, the National Radio Astronomy Observatory, is now being operated by a group of universities under contract with the Government, and several others are under construction.

Although most observatories operate with relatively small staffs, a few large ones employ a number of astronomers and other specialists. One midwestern university observatory is staffed by some 10 astronomers who hold teaching positions in the university; half a dozen full-time research assistants, technicians (computers and observers), and instrument makers; together with a number of secretaries, a part-time librarian, and a dozen graduate students, most of whom work part time as research or teaching assistants.

Since celestial observations are carried on mainly at night, the working hours of observing astronomers may be irregular during periods when conditions are favorable for viewing. These work schedules, however, are less of a handicap than they may appear, since a short period of observation with modern photographic and electronic instruments provides material for long periods of analysis between observing sessions. Of course, work schedules of some astronomers fall entirely within the customary 40-hour workweek.

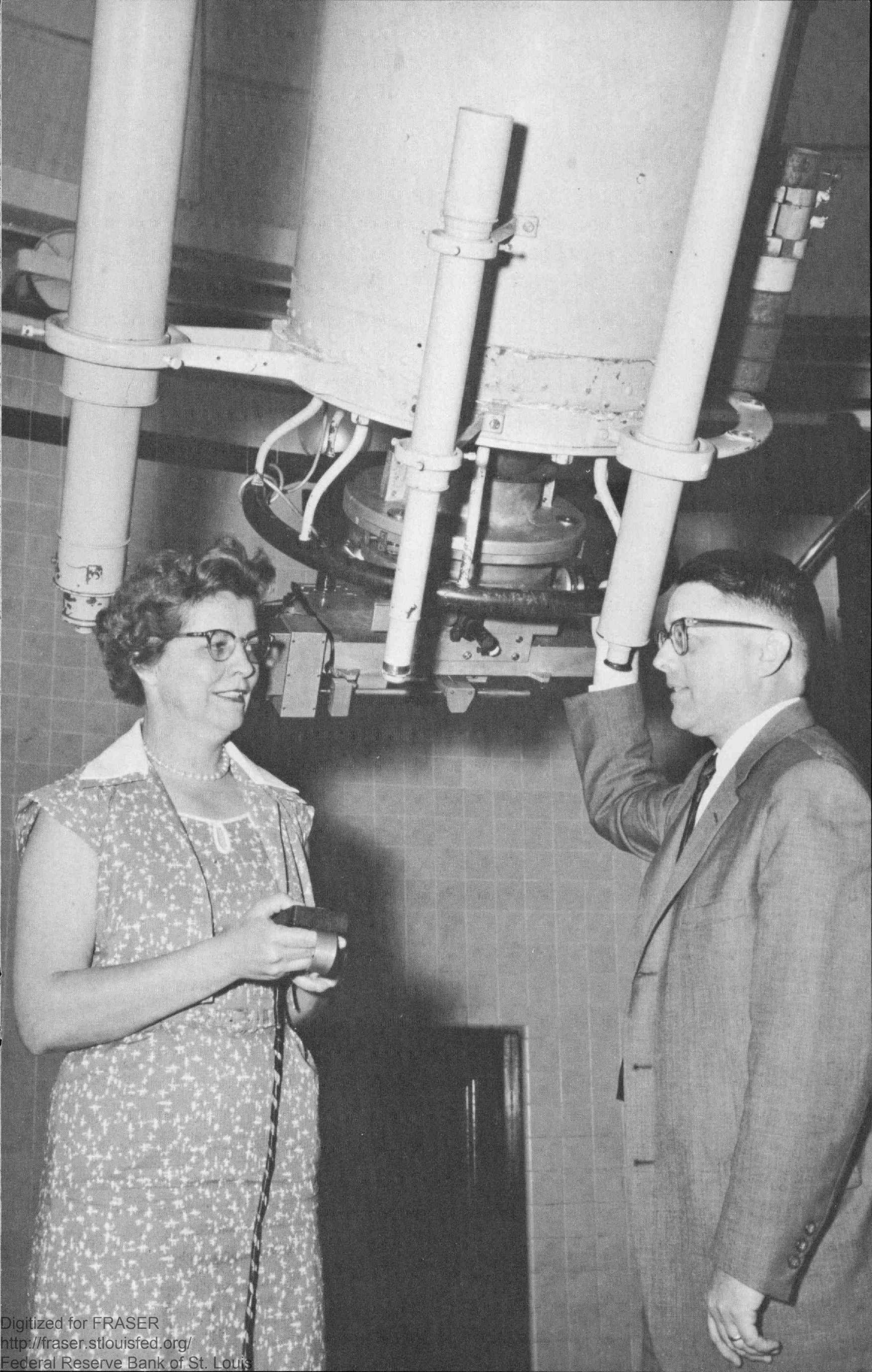
Women Astronomers at Work

The principal employers of women astronomers are the large astronomical laboratories and observatories connected with universities, research foundations, and the Federal Government. According to the listing of women astronomers on the 1954–55 National Register of Scientific and Technical Personnel, the overwhelming majority worked for institutions of higher learning. Almost all of the others were employed by the Government, with only a few in nonprofit foundations and none in private industry.

The majority of women in astronomy do research work. This activity was predominant for women on the Register for all major employers of women astronomers. However, teaching was almost as important in colleges and universities. Many women researchers are engaged as computers or research assistants. A computer may make measurements on astronomical photographs or spectrograms or

These astronomers, a husband and wife team at the U.S. Naval Observatory, are discussing the data they have just recorded from measuring the moon's position on a 26-inch equatorial telescope.

On the basis of such observations, these astronomers in the Nautical Almanac Office compute and publish tables for the safe navigation of ships and aircraft.



compute tables of observations for analysis by a higher ranking astronomer. Some computers also determine the orbits of comets or minor planets and predict eclipses. Research assistants, with a greater degree of responsibility, also participate as part of a team in the observatory's research program. For those with a bachelor's or possibly even a master's degree, these may be terminal positions from which further advancement is very limited. Women who advance to the more responsible positions generally possess exceptional ability and perseverance, in addition to extensive graduate training.

The small group of high ranking women astronomers who are engaged in pure research, though not self-employed, are seeking answers to problems which particularly interest them. Such astronomers are especially adept in both observation and theoretical analysis, which are basic to all astronomical research. Theoretical study, which attempts to understand the operation of fundamental laws of the universe, goes hand-in-hand with observation. Examination of the information collected from observations frequently suggests relationships which lead the theoretician to predict future developments. Refined instruments or new techniques may then be required to seek additional facts which would either prove or disprove the theories.

The doctorate is practically a "must" for astronomers who hope to achieve top-level positions in teaching and research, in part because of the keen competition for the limited number of opportunities. If a young woman enrolled in a college offering few or no astronomy courses expects to do graduate work in astronomy, she should build her undergraduate program around physics or mathematics, since both are fundamental to advanced astronomical theory.

The largest group of highly trained astronomers is found on college faculties, where teaching duties are usually combined with research. Few other branches of science require such a broad degree of competence in physics and mathematics. Consequently, the teacher in smaller colleges may instruct in physics and mathematics or in a science survey course, in addition to courses in astronomy. Only a few astronomers above the rank of instructor are needed by a large astronomy department; in most colleges, one astronomer is sufficient.

These limited openings contrast with those in other scientific fields where positions are numerous because the science is directly related to some other profession, such as medicine or engineering. Research or teaching assistantships are frequently granted to graduate students. In common with teaching in all fields, teacher salaries are generally modest in relation to the amount of education required. However, the freedom to engage in research and the relative security of tenure serve as strong attractions to a teaching career.

One outstanding woman astronomer was recently promoted to a full professorship and made chairman of the Department of Astronomy at Harvard University—the first woman to have achieved this distinction. She has written numerous papers and books on the structure of galaxies and variable stars. Another, who was previously on the teaching staff of this institution, is now engaged in independent research. Several others are research associates at famous observatories.

A number of women astronomers work for the Federal Government, where they perform a variety of observations, calculations, and predictions affecting our everyday life. In 1954, nine women astronomers were employed by Federal agencies, all in the District of Columbia area. This group represented one-fifth of all astronomers on the Federal civilian payroll. Determination of official time is made at the Naval Observatory, which is also responsible for developing tables and techniques for use in the navigation of sea- and air-craft. Astronomers are employed by the Naval Research Laboratory in its radio-astronomy research program, which includes studies of thermal radiation from celestial bodies. The Army Map Service utilizes astronomers in its program for measurement of long lines and in determining relative positions of widely separated points on the earth's surface. Precise computations of latitude and longitude are carried out by astronomers in the Coast and Geodetic Survey of the U.S. Department of Commerce.

Standard requirements exist for astronomers in the Federal Service. Beginners must have received a bachelor's degree for completion of a 4-year course that includes at least 12 credit hours in astronomy and at least 18 credit hours in mathematics, including differential and integral calculus. However, a time-equivalent combination of education and specified work experience may be substituted. Those just meeting minimum qualifications may enter at $4,490 a year, under the salary schedule effective January 1958. Advancement depends upon the individual's education, experience, and ability.

One outstanding woman astronomer employed by the Government is the holder of a Ph. D. degree and head of the observational astronomy program of the National Aeronautics and Space Administration. She serves as chairman of a committee in that agency which is spearheading a program to develop an earth satellite containing astronomical telescopes.

Some women astronomers with writing ability work on technical reports and periodicals or write books and magazine articles on astronomy.

▶ One woman, for example, interprets astronomy to the reading public. She is coeditor of a number of books on science, including a collection of essays; she also wrote the biography of Maria Mitchell, first woman astronomer in America.

An Early Woman Astronomer

A hundred years ago an unassuming woman astronomer named Maria Mitchell was making history by discovering a comet (1847) and several nebulae and photographing the sun. Her interest in astronomy began when as a girl on the Island of Nantucket she helped her father in observations of the sky and mathematical computations for the guidance of sea captains in the whaling industry. Through him, she met eminent astronomers in Boston and elsewhere, and learned about their work.

While employed as a librarian Miss Mitchell pursued her independent research and in 1848 was elected an honorary member of the American Academy of Arts and Sciences—the first woman to receive this honor. A few years later she was awarded the degree of LL. D. by Hanover College.

In 1865 Miss Mitchell went to the newly established Vassar College as its first professor of astronomy and director of its observatory. An inspiring teacher, during her 20 years at Vassar she was known both at home and abroad as an astronomer of note. In 1887 Columbia University conferred on her the degree of LL. D.

Years after her death, the Maria Mitchell Observatory was dedicated in Nantucket, the Maria Mitchell Astronomical Society was named for her, and she was made a member of the Hall of Fame.

Some women astronomers are employed as curators and lecturers in the score of planetaria scattered throughout the country. Planetaria house special equipment which projects onto the inside of a dome an image of the sky as seen from a specific point on the earth. Staff members operate the projector and plan lectures, models, and other exhibits to encourage the public's interest in astronomy. Women chosen for these openings must possess—in addition to sound training in astronomy—poise, a good speaking voice, and mechanical facility in operating the equipment. In 1958, two of the directors of planetaria were women; other women have served as acting directors or as staff members.

Some women astronomers find that the small number of fellow astronomers is an advantage. They value the professional contacts and the ready interchange of opinions with their colleagues. Others are attracted by the prospect of discoveries, the immensity of distances, the vast expanse of time, and the grandeur of the phenomena. Astronomy's broadness of scope and interrelationships with other sciences appeal to still others.

Outlook for Astronomers

For astronomers lacking a doctor's degree, the majority of openings will undoubtedly continue to be as research associates, assistants, or computers in observatories. This demand is likely to be reinforced by plans for manmade satellites and space travel and by discoveries made during the International Geophysical Year (1957-58) which are still being analyzed. In practice, research is often combined with teaching, since most of the observatories are associated with universities.

Teaching opportunities for women astronomers are most likely to be available in women's colleges having access to an observatory and in larger coeducational institutions. The number of faculty positions is limited. Relatively few universities grant graduate degrees in astronomy. Moreover, student enrollments in advanced courses seldom exceed half a dozen. Astronomy classes, even in undergraduate schools, are not as heavily populated as those in other sciences, but an increase in enrollments is expected within the next few years because of the growing interest in all scientific fields and the importance of astronomy in connection with new developments, both military and nonmilitary.

Since there are relatively few positions held by full-ranking women astronomers, those who fill such posts must be particularly well qualified. Opportunities are more plentiful, of course, at less responsible levels, with the majority of the openings for research associates, assistants, and computers. Because total employment in the field is relatively small and turnover is low, openings for astronomers at any one time are not numerous. Because of the rigorous training required at advanced levels, however, the supply of top level astronomers has actually failed to keep pace with the demand. A contributing factor is that a number of graduates who major in astronomy are attracted to related fields for which their training qualifies them; for example, the fields of mathematics and physics.

Students wishing to keep abreast of scientific advances in the field of astronomy and to inform themselves as to job opportunities for women astronomers may consult the American Astronomical Society (McMillin Observatory, Ohio State University, Columbus, Ohio).

Meteorology is a field which first opened up to women during World War II. This weather observer is releasing a radiosonde to receive information about the upper air.

Meteorology

Importance and Uses of Meteorology

Meteorologists collect atmospheric data which they interpret and use as a basis for weather forecasting and for other purposes. They study the weather—which affects to a large extent our daily activities, such as the kinds of food we eat, the clothes we wear, the design and structure of our houses and buildings, our trade and means of travel, and our daily activities. Meteorology is thus of direct personal interest to everyone.

The field of meteorology is also of great scientific importance. Some leading science authorities have been calling attention to the lack of basic scientific knowledge essential for understanding the weather and for future weather control. One expert has been quoted as saying that international control of weather modification will be as essential as control over nuclear energy.

Meteorologists help to safeguard human life and to furnish man with his necessities. For example, farmers rely upon weather forecasts for their planting and harvesting plans; airlines and shipping companies may reschedule or reroute trips when storms threaten; the military regard the work of meteorologists as essential for planning strategy; communities affected by smoke or air pollution consult meteorologists for advice. Rural areas afflicted with drought are increasingly turning to cloud seeders to induce rain. Solar heating, a possibility that has interested a number of meteorologists in recent years, may become a substitute for conventional fuels in the future. Industrial meteorological services employ meteorologists to make special forecasts for such companies as movie producers on location and aircraft manufacturers who are scheduling test flights. Other businesses using the services of meteorologists include insurance firms, shipping and other establishments, and construction companies.

Meteorological research continues to engage increasing numbers in both government and private employment on problems relating to weather control, aircraft icing, solar heating, and long-range forecasting. National security considerations, together with the growing use of the atmosphere as a medium of transportation and communication, have focused attention on meteorology in connection with rockets, guided missiles, earth satellites, radioactive "fall-out," cosmic rays, and auroral activity.

Specialties in Meteorology

In meteorology, the largest group is that of the synoptic meteorologists, who analyze a variety of simultaneous weather observations in order to tell us what weather to expect. They forecast weather for specific localities after interpreting reports on temperature, humidity, rainfall, clouds, air pressure, and wind direction and velocity. The continuous procession of highs and lows (areas of barometric pressure), resembling a struggle between two forces, is translated into weather maps made simple enough for the public to read.

Climatologists are meteorologists who seek answers to such questions as: Is the weather in your part of the country generally different from earlier years? Will it be different in the future? Analyzing past weather records, these scientists predict probable weather conditions in the years ahead.

Other scientists in the field, called dynamic meteorologists, study air movement to develop principles or working rules of use to the practical "weatherman" whose reports are read in newspapers or heard on radio and television.

A fourth group—physical meteorologists—are primarily research workers who want to learn about the chemical ingredients of the atmosphere and what it has in common with electrical conductors; the behavior of such unseen travelers in the atmosphere as solar radiation, sound, light, and radio waves; and factors affecting clouds and rainfall. Meteorologists use such instruments as the barometer, thermometer, hydrometer, anemometer, and radiosonde to obtain information on atmospheric conditions.

Women in Meteorology

Meteorology is a field which first opened up to women during World War II, and women meteorologists are not numerous. Current estimates (1958) indicate a total of some 6,000 meteorologists (civilian and military), of whom over 100 are women. The Federal Government is in all probability the most important employer of women meteorologists. About half of the 46 women professional members of the American Meteorological Society in 1957 were reported in the employ of the Federal Government—13 working for the Weather Bureau, 5 for the Navy, and 3 each for the Army and Air Force. Ten were working in colleges and universities, the majority in research. Four were teaching in secondary or elementary schools, and the remainder were employed by the radio and television industry and by other private industries.

Meteorologists in the Weather Bureau perform a large number of duties in addition to the most important one of weather forecasting. Weather Bureau employees engage in hydrological research, making forecasts of water supply based on long-range estimates of rainfall, in order to assist areas threatened by water shortages. Still others make observations and compile meteorological and climatological data; analyze them to determine trends; and then interpret the results.

The Weather Bureau has an in-service training program for its personnel and grants scholarships to its meteorologists to enable them to take more advanced and specialized training. It also conducts a student-aid program whereby eligible high-school graduates and college students preparing for a career in meteorology may obtain summer jobs.

▶ One of the women meteorologists working for the Federal Government is employed in the Office of the Chief of Naval Operations. She had previously worked as an instructor and research chemist at the university where she obtained her Ph. D. degree in physical chemistry, then entered the U.S. Navy as an aerology officer where she attained the rank of lieutenant commander before returning to civilian life. Although most of her work is with a team, she did a solo job that brought her a Navy award for minimizing the guesswork in predicting where radioactive fall-out may occur. She works on the development of new types of equipment for measuring wind velocity at high altitudes for use in high altitude aircraft design. Other areas of her research include the study of fog creation and dispersal, hurricane detection and oceanographic conditions. She specializes in metal-gas catalysis and upper atmosphere.

The field of weather forecasting attracts a number of women.

▶ One is a forecaster for a major city, where she specializes in the control of its air-pollution problems.

The "weatherman" at the U.S. Weather Bureau in the capital city of one of our largest eastern States is a woman. Formerly a high school teacher of general science, she took summer courses in astronomy, meteorology, and geology. After service with the WAC during World War II, she was hired by the Federal Government as a meteorologist and has worked at various weather stations. She takes weather observations, makes weather forecasts, and presents them on the radio.

Women are eligible to serve as meteorologists or as technical assistants to meteorologists while on active military duty; many served in such jobs during World War II. (About one-third to one-half of all the meteorologists in the country are serving with the Armed Forces.) Officers are sent to educational institutions for at least 1 year to train in meteorology and are then assigned to meteorological work. The Government gives preference to veterans with training and experience of this type for civilian positions with the Armed Forces and elsewhere.

An applicant for a beginning government position must have obtained (a) a bachelor's degree, with at least 20 semester hours of study in specified subjects; or (b) 4 years of progressive technical or scientific experience in meteorology or closely related fields (such as physics or mathematics), with at least 1 year in the field of meteorology; or (c) any time-equivalent combination of the preceding. For jobs at more advanced levels, graduate study in meteorology may be substituted for the professional experience required, up to a maximum of 3 years.

Colleges and universities also engage some meteorologists. In contrast to some other scientists, meteorologists in academic institutions, as indicated by the Register, are engaged primarily in research rather than in teaching.

One of these researchers is a meteorologist who, after obtaining her Ph. D. degree, continued at the college to conduct research in the radiation laboratory and later specialized in weather radar. She now heads all radar research in weather at an engineering school that is traditionally viewed as a men's school. She is also chairman of the committee on radar meteorology of the American Meteorological Society.

Some women meteorologists, however, are employed to teach as well as to conduct research. In colleges without separate departments of meteorology, specialists in meteorology may teach geography, mathematics, physics, or geology as well as meteorology.

There are many types of work suitable for women in meteorology, and greater numbers of women may find opportunities in this field in the future as additional businesses find need for the specialized skills which meteorologists offer. Numerous commercial and industrial firms have already begun to use industrial meteorologists for intensive analysis of data on weather in order to forecast weather conditions that may harm sales or production. For example, the findings of meteorologists are very useful to public-utility companies in forecasting day-to-day changes in demand for gas or electricity; department stores use such services in interpreting sales results and in setting the most desirable dates for special "sales"; and producers of steel or heavy chemicals use the finding of meteorological consultants to control the quality of products which are influenced by the air's temperature and moisture content.

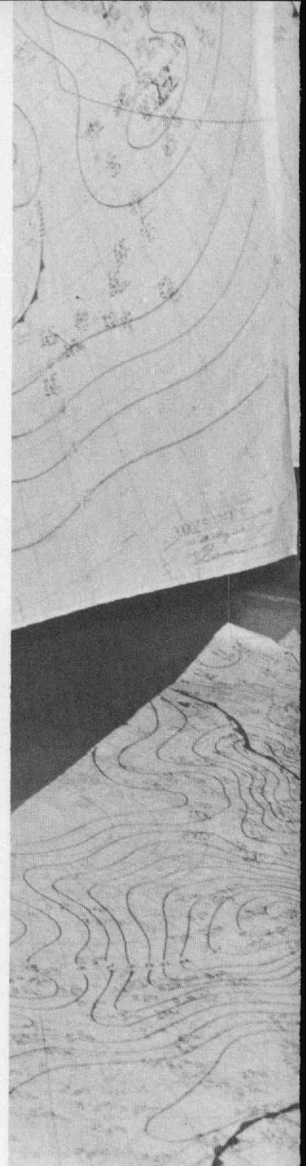
A number of meteorologists are engaged by airlines to forecast weather along flight routes—a function essential for dispatching planes, controlling flights, briefing pilots on weather conditions, and traffic management. Others are employed by private weather services to deal with clients' special weather problems, by insurance companies, and by manufacturers of meteorological instruments and balloons. A few women meteorologists are employed as editors, science writers, and librarians.

An example of the diverse experience achieved by some meteorologists is that of a woman in the research field who taught in various colleges for short periods while working for her doctorate. With the support of fellowships from various foundations, she later did research on atmospheric problems at a college in London, England. At present she is a research meteorologist at an oceanographic institute. In trying to find out what drives the wind in a hurricane, she discovered that overgrown clouds form the spiral arms of hurricanes seen on radar and release the heat energy that powers the winds. Most of her work is theoretical, making mathematical "models" of clouds and storms. In order to test her theories, she has made aircraft flights with special instruments and photographic equipment into the storm-building areas.

Inquiries as to current areas of research, as well as other aspects of meteorological work, may be addressed to the American Meteorological Society (3 Joy St., Boston 8, Mass.).

Hours of Work

Some jobs in meteorology, especially those in laboratories, are scheduled to a regular 40-hour workweek. The nature of many jobs, however, requires irregular working hours, nightwork, and rotating shifts. For example, weather stations are in operation 24 hours a day and 7 days a week, requiring a schedule of three 8-hour shifts.



This WAVE commander is assistant officer in charge of a fleet weather facility at a naval air station. As an aerologist, she charts the best route, weather-wise, for ships at sea and provides meteorological services for planes departing from her area.

Because forecasters may be required to work extra hours during a period of storm, hurricane, or other unusual weather, and because of the lengthy experience required for this work, the number of women employed as forecasters in weather stations is small. Extra compensation is often paid for field research which takes the meteorologist to distant places where living conditions are difficult.

Many women meteorologists would probably agree with one who admitted that the work is "not all sunshine" but nonetheless a challenging profession.

For prospective women scientists

Women Have the Abilities

The achievements of women in every field of science amply demonstrate women's abilities for scientific endeavors. The psychologists tell us that little, if any, difference exists in general intelligence between men and women. Test results of the General Aptitude Test Battery, developed by the U.S. Employment Service and used widely with high school seniors, also bear out the fact that there are no significant differences in aptitudes between boys and girls, and also that there are greater differences among individual girls and among individual boys than between girls as a group and boys as a group.

Moreover, what differences exist may be attributed largely to different experiences and backgrounds. The National Manpower Council's report on "Womanpower" goes beyond this and points out that there is some evidence "that women studying mechanical and technical subjects receive better grades than men who score equally well on aptitude tests." An observation of a college professor of physics provides still further evidence of women's basic aptitudes for scientific work. He states that differences in mechanical and electrical background are largely overcome by women through additional laboratory work in their freshman year; and that by the sophomore year they are at least as competent as men in the theoretical aspects of science.

Training Is the Key

Adequate training is the key to future careers in science for girls with the special aptitudes required. That girls have an interest in science is shown by a nationwide study of high school seniors made by the Educational Testing Service in 1955. Girls as well as boys indicated their interest in additional courses in science, and almost two-fifths of the senior girls wished they had taken more science and mathematics courses. The study showed, however, that fewer high school girls than boys studied mathematics and science. Almost one-half of the senior boys but less than one-tenth of the senior girls took more than 6 semesters of mathematics in high school; one-half of the senior girls as compared with three-fourths of the senior boys had 3 or more semesters of science.

Girls should, therefore, be encouraged early in their school years to include more mathematics and science subjects in their high school education.

Since aptitude tests represent just one factor in predicting vocational success, school performance in mathematics and science courses may serve as an added test of interests and abilities in the scientific fields. Further, these studies provide a good foundation for additional training and for work of many different kinds and degrees of difficulty. They are useful regardless of whether the student plans to go on to college. Moreover, such training develops analytical and logical thinking which is important in most vocations. Although graduate degrees are necessary for the most advanced research and teaching positions, there is work in scientific fields for persons at all levels of training, including the work of scientific aides, laboratory assistants, data analysts and other technicians, as well as fully qualified scientists. All of this work contributes to scientific progress and plays an essential part in it.

Satisfactions and Rewards

Science careers are highly rewarding in many ways. They offer almost unlimited scope for inquiry into the unknown, for adding to our scientific knowledge, and for development of one's highest potential. They offer relatively high starting salaries among the professions and good advancement possibilities. They offer scientists great personal satisfaction in their work, through an awareness of their usefulness to society, and through opportunities to learn and keep informed about the latest discoveries. These rewards are further heightened by the recognition and prestige accorded scientists by the community and the Nation.

Women scientists

on the National Register of Scientific and Technical Personnel

The National Register of Scientific and Technical Personnel is maintained by the National Science Foundation in cooperation with several professional societies in order to provide a central clearing house for information on such personnel.

Because registration is entirely voluntary, the Register is not a complete listing of scientists. The characteristics of the scientists included are, therefore, not necessarily representative of all scientists. They probably reflect the characteristics of the better trained or more active group.

The information in this bulletin is based on the Register for 1954–55, for which special tabulations of women scientists were provided to the Women's Bureau by the National Science Foundation.

The number of scientists on the Register differs from estimates for all scientists in two major ways: (1) The Register followed a more restrictive definition of the term "scientists". In general, persons with the doctoral degree in a scientific field and persons with the bachelor's degree (or the equivalent) plus 4 years of professional experience or training in a scientific specialty were included. However, the various professional societies interpreted these criteria differently, and (2) Register data were based on questionnaires sent to individuals, and the returning of completed questionnaires was voluntary. The principal source of the mailing lists was the membership in cooperating professional scientific societies. As a result of these factors, coverage varies considerably from field to field.

Preliminary information on the 1954–55 Register, published by the National Science Foundation in 1956, provides data on the first or primary specialty of 94,321 scientists of whom 6,880 (7.3 percent)

Table 3.—Scientists on the 1954–55 National Register of Scientific and Technical Personnel, by Field of Specialty

Field	Total on Register	Women on Register	Percent of total
All fields	94, 321	6, 880	7. 3
Astronomers	433	65	15. 0
Chemists	[1] 26, 982	1, 670	6. 2
Geologists	[2] 11, 831	226	1. 9
Meteorologists	3, 211	53	1. 7
Physicists	11, 244	299	2. 7
Other fields	[3] 40, 620	[4] 4, 567	11. 2

[1] Included among the chemists were about 3,400 scientists who listed a first specialty in biochemistry.
[2] Included in the total of 11,831 geologists were 8,395 scientists (71 percent) who listed a first specialty in geology. The remaining 3,436 scientists (29 percent) checked a first specialty in geophysics, including 299 in oceanography.
[3] Included biologists (10,421), agricultural scientists (about 5,600), and biophysicists (282); mathematicians (5,445); psychologists (12,162); and chemical engineers (6,710).
[4] Included biological scientists (1,175); mathematicians (471); psychologists (2,905); and chemical engineers (16).

were women. (See table 3.) The first specialty was indicated by the individual scientist as her highest competence, but was not necessarily the same as the specialty in which she was employed, as is illustrated by comparison of tables 3 and 4. Table 4, on "Field of Employment" is based on later tabulations of the 1954–55 Register covering 115,775 scientists of whom 7,721 (6.7 percent) were women. Analysis of the characteristics of women scientists in each of the five fields covered in this bulletin is based on special tabulations for the latter group—by field of employment.

Table 4.—Scientists on the 1954–55 National Register of Scientific and Technical Personnel, by Field of Employment

Field	Total on Register	Women on Register	Percent of total
All fields	115, 775	7, 721	6. 7
Chemists	32, 452	1, 890	5. 8
Chemical Engineers	8, 203	14	0. 2
Physicists	11, 162	305	2. 7
Geologists	8, 086	205	2. 5
Geophysicists	3, 905	65	1. 7
Astronomers	290	43	14. 8
Meteorologists	1, 838	26	1. 4
Other fields [1]	49, 839	5, 173	10. 4

[1] Covers biological scientists (including agricultural and medical), mathematicians, psychologists, geographers, other engineers, and other scientific and nonscientific specialists.

CHARACTERISTICS OF WOMEN SCIENTISTS ON THE REGISTER IN FIVE FIELDS

The five scientific fields covered in this bulletin are discussed separately in later sections of this chapter. Summaries of information collected in the 1954–55 Register are provided for each field.

Table 5, "Characteristics of Women Scientists in the 1954–55 Register—Five Selected Fields of Employment," brings together for ready reference selected information on all five fields. Several cautions should be noted, however, in making comparisons among the fields. As indicated earlier, Register coverage varies considerably from field to field and, therefore, figures for one field may be more representative than those for others. Scientists responding to the Register questionnaire did not necessarily answer all questions, thus the number reporting on each item differs from the total number of respondents in the field. (This difference is particularly significant in the "Salary" item for chemists, where only about 10 percent of the total responded.) In addition, very small numbers, such as those for astronomers and meteorologists, do not permit much analysis.

Allowing for such factors, however, one may note, for example, that the astronomers on the Register showed the highest median age and the highest level of educational attainment, as well as the greatest concentration in college or university employment and in the research and teaching functions.

On the other hand, women chemists and geologists on the Register showed the lowest median ages, the greatest concentration in private industry employment, the most direct relationship between field of major and field of employment, and high proportions at the bachelor's degree level.

Women meteorologists on the Register in many respects differed substantially from the other four groups; however, the total number of such women—26—was so small that the significance of these differences is questionable. The women meteorologists were relatively young among these scientists and were the only ones reporting a high proportion (more than one-fourth) with some college training but no degree. In addition, only among meteorologists was there a high proportion (one-fifth) with nonscientific degrees and only the meteorologists were concentrated in government employment. Less than half of the 20 meteorologists reporting on field of major had taken their highest degree in meteorology.

TABLE 5.—CHARACTERISTICS OF WOMEN SCIENTISTS IN THE 1954–55 REGISTER—FIVE SELECTED FIELDS OF EMPLOYMENT

[A. AGE AND SALARY]

Women	AGE				
	Total reporting	Under 30 years	30–49 years	50 years and over	Median age
Chemists	1,783	531	945	307	35
Physicists [1]	291	83	144	64	36
General	194	47	91	56	41
Other	97	36	53	8	32
Geologists	199	75	95	29	34
Astronomers	42	11	20	11	41
Meteorologists	20	2	15	3	36
	PERCENT DISTRIBUTION				
Chemists	100	30	53	17	
Physicists [1]	100	29	49	22	
General	100	24	47	29	
Other	100	37	55	8	
Geologists	100	38	48	15	
Astronomers	100	26	48	26	
Meteorologists	100	10	75	15	

	SALARY (1954–55)				
	Total reporting	Under $4,000	$4,000–5,999	$6,000 and over	Median salary
Chemists	[2] 196	41	107	48	$5,138
Physicists [1]	270	42	132	96	5,451
General	175	36	87	52	5,211
Other	95	6	45	44	5,865
Geologists	176	28	88	60	5,333
Astronomers	40	13	22	5	4,538
Meteorologists	26	3	19	4	4,833
	PERCENT DISTRIBUTION				
Chemists	100	21	55	24	
Physicists [1]	100	16	49	36	
General	100	21	50	30	
Other	100	6	47	46	
Geologists	100	16	50	34	
Astronomers	100	33	55	13	
Meteorologists	100	12	73	15	

[1] General includes general physics, theoretical physics, mechanics and heat, cryogenics, optics, and acoustics. Other includes electronics, electromagnetism, atomic and molecular phenomena, nuclear physics, and solid state physics.

[2] Salary was reported by only 196 women chemists or about 10 percent of women respondents to the survey.

Note.—Percents do not necessarily add to 100 due to rounding.

Source: 1954–55 National Register of Scientific and Technical Personnel. National Science Foundation (Washington, D.C.).

TABLE 5.—CHARACTERISTICS OF WOMEN SCIENTISTS IN THE 1954–55 REGISTER—FIVE SELECTED FIELDS OF EMPLOYMENT—Continued

[B. DEGREE AND EDUCATIONAL MAJOR]

Women	DEGREE					
	Total reporting	No college or no degree	Bachelor's	Master's	Doctoral	M.D.
Chemists	1,886	11	648	561	655	11
Physicists [1]	297	6	74	111	105	1
General	199	5	49	81	63	1
Other	98	1	25	30	42	----------
Geologists	204	2	91	76	35	----------
Astronomers	40	----------	7	15	18	----------
Meteorologists	22	6	7	6	3	----------
	PERCENT DISTRIBUTION					
Chemists	100	1	34	30	35	1
Physicists [1]	100	2	25	37	35	(2)
General	100	3	25	41	32	1
Other	100	1	26	31	43	----------
Geologists	100	1	45	37	17	----------
Astronomers	100	----------	18	38	45	----------
Meteorologists	100	27	32	27	14	----------

	EDUCATIONAL MAJOR			
	Total reporting	Same as employment specialty	Other sciences, mathematics, or engineering	Nonscientific
Chemists	1,874	1,654	172	48
Physicists [1]	282	211	58	13
General	186	131	43	12
Other	96	80	15	1
Geologists	204	176	23	5
Astronomers	39	31	6	2
Meteorologists	20	9	7	4
	PERCENT DISTRIBUTION			
Chemists	100	88	9	3
Physicists [1]	100	75	21	5
General	100	70	23	6
Other	100	83	16	1
Geologists	100	86	11	2
Astronomers	100	79	15	5
Meteorologists	100	45	35	20

[1] General includes general physics, theoretical physics, mechanics and heat, cryogenics, optics, and acoustics. Other includes electronics, electromagnetism, atomic and molecular phenomena, nuclear physics, and solid state physics.

[2] Less than 1 percent.

Note.—Percents do not necessarily add to 100 due to rounding.

Source: 1954–55 National Register of Scientific and Technical Personnel. National Science Foundation (Washington, D.C.).

TABLE 5.—CHARACTERISTICS OF WOMEN SCIENTISTS IN THE 1954–55 REGISTER—FIVE SELECTED FIELDS OF EMPLOYMENT—Continued

[C. EMPLOYER AND FUNCTION]

Women	EMPLOYER [1]				
	Total reporting	College or university	Government	Private industry	Nonprofit foundation
Chemists	1,885	717	228	758	182
Physicists [2]	305	162	56	69	18
General	204	131	33	32	8
Other	101	31	23	37	10
Geologists	205	24	79	93	9
Astronomers	43	33	8		2
Meteorologists	25	7	17		1
	PERCENT DISTRIBUTION				
Chemists	100	38	12	40	10
Physicists [2]	100	53	18	23	6
General	100	64	16	16	4
Other	100	31	23	37	10
Geologists	100	12	39	45	4
Astronomers	100	77	19		5
Meteorologists	100	28	68		4

Women	FUNCTION [3]				
	Total reporting	Research	Teaching	Consulting	Other
Chemists	1,879	900	392	505	82
Physicists [2]	303	132	118	43	10
General	203	54	114	31	4
Other	100	78	4	12	6
Geologists	205	123	14	53	15
Astronomers	43	27	13	2	1
Meteorologists	21	10		7	4
	PERCENT DISTRIBUTION				
Chemists	100	48	21	27	4
Physicists [2]	100	44	39	14	3
General	100	27	56	15	2
Other	100	78	4	12	6
Geologists	100	60	7	26	7
Astronomers	100	63	30	5	2
Meteorologists	100	48		33	19

[1] Employer: *Government*—Federal (includes Armed Forces), State, local, international governmental organizations. *Private industry* includes self-employed. *Nonprofit foundation* includes private hospitals and clinics.

[2] General includes general physics, theoretical physics, mechanics and heat, cryogenics, optics, and acoustics. Other includes electronics, electromagnetism, atomic and molecular phenomena, nuclear physics, and solid state physics.

[3] Function: *Research* includes development or field exploration. *Consulting* includes clinical practice; engineering; economics or evaluation; technical writing; editing; patent or library work; design; inspection; clinical analysis; testing; analytical or process control; technical sales and service, or marketing and purchasing. *Other* includes management or administration; production; operation, maintenance; construction or installation.

Note.—Percents do not necessarily add to 100 due to rounding.
Source: 1954–55 National Register of Scientific and Technical Personnel. National Science Foundation (Washington, D.C.).

CHARACTERISTICS OF WOMEN CHEMISTS ON THE REGISTER

Employment

Almost 1,900 women were reported employed as chemists on the 1954-55 National Register of Scientific and Technical Personnel. Some 40 percent of the women chemists were employed by private industry; about the same proportion, by colleges and universities; and about 10 percent each by Government and nonprofit foundations. Private industry was the primary employer of specialists in spectroscopy and pharmaceutical chemistry. (See tables 5, 6A, and 6B.)

Function

Research was the primary activity of nearly half of the women chemists, while teaching was primary for about one-fifth. Somewhat over 10 percent of the chemists reported inspection as their chief function, and an equal proportion reported technical writing. Other than in the colleges, where teaching predominated, research was the leading activity for chemists. Even in the colleges, however, research was the primary function of 40 percent of the chemists. Such activities as technical writing and inspection and testing, along with research, were concentrated mainly in private industry.

Education

About two-thirds of the women chemists held graduate degrees, over half of which were doctoral degrees. A high proportion of those with a bachelor's degree had taken graduate work. A substantial majority held their highest degree in chemistry. Most of the remainder had majored in biochemistry, biological sciences, or medical sciences. Among the latter group there were a number of women with M.D. degrees who were engaged primarily in research.

Educational attainment was highest among those employed by colleges and lowest among those working for private industry. For example, more than half of the college-employed held the doctorate; about one-third of those employed by government or nonprofit institutions; and nearly one-sixth of those in private industry.

Age

The average (median) age of the chemists was 35; almost one-third were still in their 20's. The largest number of those under 30 worked in private industry, and the largest number of those who were 50

TABLE 6A.—WOMEN CHEMISTS OF THE 1954–55 REGISTER, BY EMPLOYER AND FUNCTION

[Total reporting, 1,890]

	Employer [1]				Function [2]			
	College or university	Government	Private industry	Nonprofit organization	Research	Teaching	Consulting	Other
Age:								
Under 30 years	130	66	278	56	295	49	173	10
30–49 years	363	116	372	92	467	185	245	45
50 years and over	176	39	68	22	94	125	63	22
Median age	40	35	32	34	33	45	33	44
Salary (1954–55):								
Under $4,000	28	4	2	7	33	3	3	2
$4,000–$5,999	69	18	6	13	84	15	2	2
$6,000 and over	24	13	4	7	35	7	2	4
Median salary	$4,855	$5,679	$5,333	$5,350	$5,146	$4,864	$5,250	$6,500
Degree:								
No college or no degree	1		8	2	2		9	
Bachelor's	74	83	420	68	266	35	310	33
Master's	228	68	214	50	250	154	133	22
Doctoral	405	74	116	59	370	203	52	25
M.D	6	2		3	9		1	1
Function: [2]								
Research	285	145	361	107				
Teaching	388			2				
Consulting	27	64	361	53				
Other	15	17	33	17				

[1] Employer: *Government*—Federal (includes Armed Forces), State, local, international governmental organizations. *Private industry* includes self-employed. *Nonprofit foundation* includes private hospitals and clinics.

[2] Function: *Research* includes development or field exploration. *Consulting* includes clinical practice; engineering; economics or evaluation; technical writing; editing; patent or library work; design; inspection; clinical analysis; testing; analytical or process control; technical sales and service, or marketing and purchasing. *Other* includes management or administration; production; operation, maintenance; construction or installation.

TABLE 6B.—WOMEN CHEMISTS ON THE 1954–55 REGISTER, BY DEGREE AND SALARY

	Degree					Salary (1954–55)			
	No college or no degree	Bachelor's	Master's	Doctoral	M.D.	Under $4,000	$4,000–5,999	$6,000 and over	Median salary
Age:									
Under 30 years		282	178	69	2	19	24	1	
30–49 years	1	296	259	381	6	17	62	30	
50 years and over		38	94	171	3	3	13	13	
Median age		31	34	41	41	30	35	43	
Salary (1954–55):									
Under $4,000	1	5	16	18	1				
$4,000–$5,999		9	16	76	4				
$6,000 and over		1	2	41	4				
Median salary		$4,416	$4,125	$5,411	$5,750				
Educational major:									
Chemistry and biochemistry	1	594	471	586		26	67	29	$5,220
Biological sciences		23	25	53		11	31	13	4,868
Other sciences, mathematics, or engineering	3	16	30	9	11	3	9	6	5,400
Nonscientific		9	35	4					

SOURCE: 1954–55 National Register of Scientific and Technical Personnel. National Science Foundation, (Washington, D.C.).

years or over were in colleges and universities. This reflects in part the higher levels of education needed for teaching.

Salary

Only a very small number (200) of the women chemists responded to the salary section of the Register survey. For those who reported, the average (median) salary was above $5,100 a year in 1954-55. Because of the small numbers involved, the salary differentials which appear in tables 6A and 6B are not very meaningful. However, since only very limited information on salaries is available, the data from the 1954–55 Register have been included here.

CHARACTERISTICS OF WOMEN PHYSICISTS ON THE REGISTER

Just over 300 women physicists were reported on the 1954–55 National Register of Scientific and Technical Personnel. Two-thirds of the women physicists worked in general physics,[3] and the remaining 101 specialized in such areas as electronics and nuclear physics. (See tables 5, 7A, and 7B.)

Employment

More than half of the women were employed by colleges and were, for the most part, general physicists rather than specialists. Almost one-fourth worked for private industry, and a majority of these were specialists. Government employed almost one-fifth of the total, largely in general physics. The remainder worked for nonprofit foundations.

Function

Seven out of ten of the college-employed physicists were engaged primarily in teaching; most of the remainder, in research. Research, as a primary activity, was more common for the specialists in colleges

[3] "General" physics, as used on the Register and noted in table 5, includes general physics, theoretical physics, mechanics and heat, cryogenics, optics, and acoustics. Specialists, as used here, refers to "other" physicists in the Register who specialized in electronics, electromagnetism, atomic and molecular phenomena, nuclear physics, and solid state physics.

TABLE 7A.—WOMEN PHYSICISTS ON THE 1954–55 REGISTER, BY EMPLOYER AND FUNCTION

[Total reporting, 305]

	Employer [1]				Function [2]			
	College or university	Government	Private industry	Nonprofit organization	Research	Teaching	Consulting	Other
Age:								
Under 30 years	35	18	26	4	51	17	14	
30–49 years	71	28	34	11	65	51	20	8
50 years and over	51	6	4	3	10	46	6	1
Median age	42	32	32	35	32	45	33	38
Salary (1954–55):								
Under $4,000	38	1	1	2	10	29	2	1
$4,000–$5,999	62	30	34	6	63	43	21	4
$6,000 and over	34	24	30	8	50	25	16	4
Median salary	$4, 829	$5, 848	$5, 861	$6, 000	$5, 713	$4, 722	$5, 682	$5, 833
Degree:								
No college or no degree	2	1	3		3	1	1	1
Bachelor's	20	19	28	7	40	13	16	5
Master's	69	20	20	2	36	56	17	1
Doctoral	65	16	15	9	51	43	8	2
M.D	1					1		
Function: [2]								
Research	39	38	45	10				
Teaching	114	1	3					
Consulting	5	14	18	6				
Other	3	2	3	2				

[1] Employer: *Government*—Federal (includes Armed Forces), State, local, international governmental organizations. *Private industry* includes self-employed. *Nonprofit foundation* includes private hospitals and clinics.

[2] Function: *Research* includes development or field exploration. *Consulting* includes clinical practice; engineering; economics or evaluation; technical writing; editing; patent or library work; design; inspection; clinical analysis; testing; analytical or process control; technical sales and service, or marketing and purchasing. *Other* includes management or administration; production; operation, maintenance; construction or installation.

TABLE 7B.—WOMEN PHYSICISTS ON THE 1954–55 REGISTER, BY DEGREE AND SALARY

	Degree					Salary (1954–55)			
	No college or no degree	Bachelor's	Master's	Doctoral	M.D.	Under $4,000	$4,000–5,999	$6,000 and over	Median salary
Age:									
Under 30 years	1	38	31	13		17	50	10	
30–49 years	1	30	49	60		15	56	59	
50 years and over		4	25	30	1	9	20	22	
Median age		29	36	42		32	33	39	
Salary (1954–55):									
Under $4,000	2	12	21	7					
$4,000–$5,999	2	44	47	34	1				
$6,000 and over	2	12	29	51					
Median salary	$5, 500	$4, 917	$5, 188	$6, 238					
Educational major:									
Physics	2	45	77	80		36	89	63	$5, 392
Other sciences, mathematics, or engineering		19	24	14	1	4	29	18	5, 375
Nonscientific	1	4	3	5			5	7	6, 250

SOURCE: 1954–55 National Register of Scientific and Technical Personnel. National Science Foundation (Washington, D.C.).

than for the general physicists. Similarly, the primary activity of the majority of physicists in private industry and government was research, although some were engaged primarily in technical writing, inspection, or management.

Education

Three out of four of the women physicists had taken their highest degree in physics, and a majority of the remainder reported mathematics or chemistry. Graduate degrees were held by three out of four; and the number of doctoral degrees was almost as high as the number of master's degrees.

Although graduate training is deemed important by all types of employers of physicists, only about one-half of the women physicists in private industry had attained a graduate degree. By contrast, almost 85 percent of those employed by colleges and almost 64 percent of the women physicists in government held graduate degrees. The highest proportion of physicists with doctoral degrees was found in colleges and universities, followed next in order by government and private industry.

Age

Half of the physicists were under 36 years of age, but as might be expected in view of the fairly recent development of some specialties in this field, the specialists were much younger on the average (32 years) than the general physicists (41 years). The women employed by colleges were, on the average, 10 years older than those in private industry or government.

Salary

The average (median) salary for all the women physicists who reported their salaries was over $5,400 a year; that for specialists was close to $5,900. College-employed physicists averaged about $1,000 a year below physicists employed by private industry and by government. About one out of five of the women physicists earned at least $7,000. Average salaries increased with each level of education; thus the median salary of bachelor's degree holders was more than $200 below that of physicists with the master's degree, and more than $1,300 below that of the holders of a doctoral degree.

CHARACTERISTICS OF WOMEN GEOLOGISTS ON THE REGISTER

Slightly more than 200 women geologists were reported on the 1954–55 National Register of Scientific and Technical Personnel. (See tables 5, 8A, and 8B.)

Employment

The highest proportion (45 percent) of the geologists worked for private industry, with the next largest group (almost 40 percent) employed by government. Much smaller numbers worked for colleges and universities (about 12 percent) and for nonprofit foundations (4 percent). Geologists specializing in petroleum and natural gas were employed primarily in private industry. A few such specialists were self-employed. Most of those in other branches of geology were employed by government agencies.

Function

Research or field exploration engaged a majority (three out of five) of the geologists. Slightly more than 15 percent were doing technical writing. Teaching, management or administration, and consulting work each accounted for about 7 percent of the total, and a small number were in inspection or production work. In private industry, research work predominated; in government, research and technical writing; in colleges, teaching and research.

Education

Some 85 percent had taken their highest degree in geological sciences. Over half held graduate degrees, and nearly one out of five had attained the doctoral degree.

All the geologists employed by colleges held graduate degrees. Next in educational attainment were those employed by nonprofit foundations, followed by government. Whereas 44 percent of the government geologists had attained only the bachelor's degree, about 60 percent of the geologists in private industry held only the bachelor's degree. Further, more than twice as many government geologists as geologists in private industry held the Ph.D.

Table 8A.—Women Geologists on the 1954–55 Register, by Employer and Function

[Total reporting, 205]

	Employer[1]				Function[2]			
	College or university	Government	Private industry	Nonprofit organization	Research	Teaching	Consulting	Other
Age:								
Under 30 years	3	27	43	2	47	2	23	3
30–49 years	12	39	42	2	60	7	21	7
50 years and over	9	10	7	3	12	5	8	4
Median age	46	35	31	44	33	45	34	45
Salary (1954–55):								
Under $4,000	10	10	5	3	9	4	12	3
$4,000–$5,999	7	40	39	2	56	5	19	8
$6,000 and over	6	23	29	2	41	4	11	4
Median salary	$5,083	$5,036	$5,643	$4,500	$5,571	$5,375	$4,750	$4,900
Degree:								
No college or no degree			1	1	2			
Bachelor's		35	54	2	58	1	27	5
Master's	11	30	30	5	40	6	23	7
Doctoral	13	14	7	1	22	7	3	3
M.D.								
Function:[2]								
Research	7	42	71	3				
Teaching	13		1					
Consulting	3	29	18	3				
Other	1	8	3	3				

[1] Employer: *Government*—Federal (includes Armed Forces), State, local, international governmental organizations. *Private industry* includes self-employed. *Nonprofit foundation* includes private hospitals and clinics.

[2] Function: *Research* includes development or field exploration. *Consulting* includes clinical practice; engineering; economics or evaluation; technical writing; editing; patent or library work; design; inspection; clinical analysis; testing; analytical or process control; technical sales and service, or marketing and purchasing. *Other* includes management or administration; production; operation, maintenance; construction or installation.

Table 8B.—Women Geologists on the 1954–55 Register, by Degree and Salary

	Degree					Salary (1954–55)			
	No college or no degree	Bachelor's	Master's	Doctoral	M.D.	Under $4,000	$4,000 to 5,999	$6,000 and over	Median salary
Age:									
Under 30 years	1	51	23			15	43	6	
30–49 years		31	40	23		9	35	38	
50 years and over		5	12	12		3	8	16	
Median age		29	35	47		29	30	43	
Salary (1954–55):									
Under $4,000		12	13	3					
$4,000–$5,999		46	30	12					
$6,000 and over		17	25	18					
Median salary		$4,879	$5,471	$6,214					
Educational major:									
Geology	1	83	66	26		23	74	53	$5,389
Other sciences, mathematics, or engineering		6	8	8		5	9	7	5,300
Nonscientific		2	2	1		1	4		4,500

Source: 1954–55 National Register of Scientific and Technical Personnel. National Science Foundation (Washington, D.C.).

Age

The average age of geologists was 34, with the greatest concentration in the age group 25 to 30. On the average, those in private industry were youngest, followed by those in government. Geologists employed by colleges (all of whom held graduate degrees) were more mature, averaging about 46 years of age.

Salary

The average (median) salary for women geologists was just over $5,300 a year. Average salaries were highest in private industry and lowest in nonprofit organizations. The higher average in private industry reflected in part the higher salaries for petroleum and natural gas specialists, a few of whom received $12,500 or more a year. Although the averages for geologists employed by colleges and universities and by government were almost the same, a much higher proportion of the college-employed reported salaries in the lowest range.

CHARACTERISTICS OF WOMEN ASTRONOMERS ON THE REGISTER

Employment

Colleges and universities employed three-fourths of the 43 women astronomers reported on the 1954–55 National Register of Scientific and Technical Personnel. Most of the remainder worked for the Government; a few worked for nonprofit foundations. None was reported in private industry. (See tables 5, 9A, and 9B.)

Function

Research was the predominant activity reported by astronomers in educational institutions as well as in government and in nonprofit foundations. Almost as many of the astronomers employed by educational institutions were engaged in teaching as in research; some did both.

Education

The typical woman astronomer on the Register had achieved a graduate degree and had majored in astronomy. Four-fifths of the women astronomers had taken their highest degree in that science or in astrophysics; a few had majored in the related field of mathematics.

Table 9A.—Women Astronomers on the 1954–55 Register, by Employer and Function

[Total reporting, 43]

	Employer[1]				Function[2]			
	College or university	Government	Private industry	Nonprofit organization	Research	Teaching	Consulting	Other
Age:								
Under 30 years	7	4			10	1		
30–49 years	15	4		1	11	7	1	1
50 years and over	10			1	5	5	1	
Median age	45	30			34	48		
Salary (1954–55):								
Under $4,000	12			1	9	3	1	
$4,000–$5,999	13	8		1	14	6	1	1
$6,000 and over	5				2	3		
Median salary	$4, 273	$5, 333			$4, 500	$4, 500		
Degree:								
No college or no degree								
Bachelor's	3	4			7			
Master's	10	3		2	10	2	2	1
Doctoral	17	1			8	10		
M.D								
Function:[2]								
Research	18	7		2				
Teaching	13							
Consulting	1	1						
Other	1							

[1] Employer: *Government*—Federal (includes Armed Forces), State, local, international governmental organizations. *Private industry* includes self-employed. *Nonprofit foundation* includes private hospitals and clinics.

[2] Function: *Research* includes development or field exploration. *Consulting* includes clinical practice; engineering; economics or evaluation; technical writing; editing; patent or library work; design; inspection; clinical analysis; testing; analytical or process control; technical sales and service, or marketing and purchasing. *Other* includes management or administration; production; operation, maintenance; construction or installation.

Table 9B.—Women Astronomers on the 1954–55 Register, by Degree and Salary

	Degree					Salary (1954–55):			
	No college or no degree	Bachelor's	Master's	Doctoral	M.D.	Under $4,000	$4,000–5,999	$6,000 and over	Median salary
Age:									
Under 30 years		5	3	3		5	6		
30–49 years		2	7	10		2	13	2	
50 years and over			5	5		5	3	3	
Median age		28	39	46		38	38	53	
Salary (1954–55):									
Under $4,000		3	6	3					
$4,000–$5,999		4	7	9					
$6,000 and over				5					
Median salary		$4, 500	$4, 250	$4, 688					
Educational major:									
Astronomy or astrophysics		1	13	16		8	16	5	$4, 650
Other sciences, mathematics, or engineering		3		1		1	4		4, 750
Nonscientific		1				2			

Source: 1954–55 National Register of Scientific and Technical Personnel. National Science Foundation (Washington, D. C.).

Almost half of the total and virtually all of those teaching held doctoral degrees. All of those who held only the bachelor's degree were engaged in research, either for government or for colleges.

Age

Women astronomers as a group were older than women in the other sciences covered in this report. Less than half were under 35 years of age; the majority were over 40. Teachers and other holders of the doctorate were among the older group, while government research workers (most of them possessors of the bachelor's degree only) were among the younger group. Half of the latter were between 25 and 30 years of age.

Salary

On the average, salaries of astronomers were lower than those of any other group of scientists included in this report. The average (median) salary for women astronomers was just over $4,500 a year, with those employed by colleges generally reporting on the low side. Only a few teachers reported salaries much above the overall average, despite the fact that most of them held doctoral degrees and were over 40 years of age. The lowest salaries, however, were reported by holders of the bachelor's degree and the highest, by holders of doctorates. Otherwise, there was considerable overlapping of salaries among the various degree levels.

CHARACTERISTICS OF WOMEN METEOROLOGISTS ON THE REGISTER

Employment

Over two-thirds of the 26 women meteorologists reported on the 1954–55 National Register of Scientific and Technical Personnel worked for government. Most of the remainder were employed by colleges and universities. None was reported working for private industry. (See tables 5, 10A, and 10B.)

Function

Consulting (here including technical writing and testing) was the principal activity of meteorologists employed by government. Most of the remainder were engaged in research. Virtually all the college-employed meteorologists were engaged primarily in research; none was teaching.

TABLE 10A.—WOMEN METEOROLOGISTS ON THE 1954–55 REGISTER, BY EMPLOYER AND FUNCTION

[Total reporting, 26]

	Employer [1]				Function [2]			
	College or university	Government	Private industry	Nonprofit organization	Research	Teaching	Consulting	Other
Age:								
Under 30 years	1	1			1		1	
30–49 years	4	9		1	8		3	2
50 years and over	2	1			1		1	1
Median age	46	36			34		38	39
Salary (1954–55):								
Under $4,000	2				2		1	
$4,000–$5,999	4	15			6		6	2
$6,000 and over	1	2		1	2			2
Median salary	$5,167	$4,773			$5,000		$4,833	$5,500
Degree:								
No college or no degree		5			2		1	1
Bachelor's	2	5			2		3	1
Master's	4	2			4		1	1
Doctoral	1	1		1	2			1
M. D.								
Function: [2]								
Research	6	3		1				
Teaching								
Consulting		6						
Other	1	3						

[1] Employer: *Government*—Federal (includes Armed Forces), State, local, international governmental organizations. *Private industry* includes self-employed. *Nonprofit foundation* includes private hospitals and clinics.

[2] Function: *Research* includes development or field exploration. *Consulting* includes clinical practice; engineering; economics or evaluation; technical writing; editing; patent or library work; design; inspection; clinical analysis; testing; analytical or process control; technical sales and service, or marketing and purchasing. *Other* includes management or administration; production; operation, maintenance; construction or installation.

TABLE 10B.—WOMEN METEOROLOGISTS ON THE 1954–55 REGISTER, BY DEGREE AND SALARY

	Degree					Salary (1954–55)			
	No college or no degree	Bachelor's	Master's	Doctoral	M.D.	Under $4,000	$4,000 to 5,999	$6,000 and over	Median salary
Age:									
Under 30 years		1	1				2		
30–49 years	4	5	4	2		2	10	3	
50 years and over		1	1	1		1	1	1	
Median age	35	34	43	43		48	34	40	
Salary (1954–55):									
Under $4,000	1	1	1						
$4,000–$5,999	5	6	4						
$6,000 and over			1	3					
Median salary	$4,400	$5,125	$5,333	$6,750					
Educational major:									
Meteorology		3	5	1		1	6	2	$5,500
Other sciences, mathematics, or engineering	2	3	1	1		1	5	1	4,625
Nonscientific	2	1		1		1	2	1	5,000

SOURCE: 1954–55 National Register of Scientific and Technical Personnel. National Science Foundation (Washington, D.C.).

Education

The women meteorologists on the Register had majored in a wide variety of subjects. Less than half of the women had taken their highest degree in meteorology. Almost as many had majored in such fields as mathematics, chemistry, or one of the biological or other physical sciences. A relatively high proportion, however, had majored in nonscientific fields. Although only nine held graduate degrees (most of them master's), many had taken some work beyond the bachelor's degree. More than one out of four had attended college but had not received a degree. Most of the college-employed held graduate degrees, while most of those employed by the government had only a bachelor's degree or no degree.

Age

The women meteorologists were a fairly young group; two-thirds were under 40 years of age. All of those who had not completed college were in their thirties. On the whole, those employed by colleges were older than those in government.

Salary

Salaries were generally modest in relation to those of the other women scientists in this report. The average (median) salary reported by women meteorologists was just over $4,800 a year. Although a few college-employed meteorologists reported salaries in the lowest bracket, and one government meteorologist reported a salary in the $9,000 to $10,000 bracket, the average college meteorologist was paid more than the average government meteorologist. Highest salaries were reported by the holders of doctoral degrees and lowest, by those who had not been graduated from college.

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