DR. FRED M. BULLARD, professor of geology and mineralogy at the University of Texas, will continue his studies on Parícutin this summer under a grant from the Geological Society of America. He will teach a course on the "Volcanoes of Mexico" in the Summer School of the National University of Mexico, in collaboration with Dr. Ezequiel Ordoñez, as a member of the faculty of the field school sponsored by the Institute of Latin American Studies of the University of Texas. Following the session he plans to spend approximately three months in a field study of Parícutin and related areas.

DR. ALBERT L. HENNE, professor of chemistry at the Ohio State University, an authority on fluorine compounds, is spending several weeks as research associate at the University of California at Los Angeles. While there he will deliver the William Conger Morgan Memorial Lecture, speaking on "Aliphatic Fluorides."

THE Messenger Lectures of Cornell University for 1943–44 were given during April by Dr. Griffith Taylor, professor of geography at the University of Toronto. The series of six lectures was entitled "Our Evolving Civilization."

DR. HOWARD T. KARSNER, professor of pathology at Western Reserve University, delivered on May 18 the first Frederick Robert Zeit Lecture sponsored by the Xi chapter of the Alpha Kappa Kappa Fraternity at the Medical School of Northwestern University. He spoke on "Hepatic Cirrhosis."

DR. R. R. SPENCER, chief of the National Cancer Institute, Bethesda, Md., delivered on May 3 the George Chase Christian Cancer Lecture at the Medical School of the University of Minnesota. The lecture was entitled "Biological Adjustment and Its Relation to the Carcinogenic Process." He also spoke on "Newer Techniques in Cancer Research" and on "The Public Stake in Cancer Research."

THE American Physical Society will meet at Rochester, N. Y., on June 23 and 24. The two hundred and sixty-second meeting will be held on July 22 at the University of California at Berkeley.

THE twentieth annual meeting of the West Virginia Academy of Science was held at Fairmont State Teachers College on May 5 and 6. While the program was somewhat smaller than usual there was an unusually large attendance considering the travel restrictions. The Division of Higher Education of the State Education Association was invited to hold its meeting with the academy and to participate in the program. Dr. Horace B. English, of the Ohio State University, gave the address at the annual banquet. He spoke on "Psychology in the Post-war World." The officers elected for the coming year are E. Meade McNeill, Athens, *President;* Hanibal A. Davis, Morgantown, *Vice-president;* Nelle Ammons, Morgantown, *Treasurer;* J. E. Judson, Buckhannon, *Secretary.* The next annual meeting will be held at Concord State Teachers College at Athens, W. Va.

RUTGERS UNIVERSITY has established a research council to promote research in all departments of the university. A survey is now being made of personnel and facilities to determine where new funds for research can best be invested. The council consists of nine members representing various fields of knowledge and colleges of the university. Dr. William H. Cole, since 1928 professor of physiology and biochemistry, has been appointed director of the council. He will serve in a staff relationship to deans, heads of departments and members of the faculty concerning research programs, and will represent the university in developing reciprocal arrangements with governmental, industrial, business and professional institutions outside the university. A special research fund has been placed at the disposal of the council and applications for grants for next year are now being considered.

DISCUSSION

THE OPERATIONAL VIEWPOINT IN HARDNESS MEASUREMENTS

THE appearance of a recent book[1] on the subject of hardness—the first, so the author says, to be written by a physicist—reopens an old question (actually it was never closed) which is of vital importance in the war effort as well as of general interest to science and industry.

The problem of hardness is distinctly a problem for the physicist, but the realm of physics must be understood to include such extensive fields as metallurgy, chemistry, x-rays, quantum theory and mathematics; and the subject of hardness is not only of interest to these but to a host of professions and industries ranging from the iron and steel industry to dentistry, and from ordnance to pottery. The importance of the concept needs no demonstration when one considers that the hardness of armor plate or shell tips might mean the difference between the survival or downfall of democracy and freedom.

In recent years the long existing confusion about hardness has been partially but not completely clari-

[1] "Hardness and Hardness Measurements," by Professor S. R. Williams, Amherst College. Published by American Society for Metals. 1942.

fied. Strangely enough, modern general physics texts say little or nothing about hardness, though in relation to touch it is one of our most common experiences in the physical world. Older physics texts usually listed hardness as one of the important properties of matter but went little further. A leading text of fifty years ago said, "Hardness is a property that can not be measured," and a popular dictionary says that "hardness is the quality or state of being hard." Neither of these statements is useful. The difficulty is that the word is not only asked to do double duty in the world of common experience and in the technical world, but it is also asked to do multiple duty in the technical world as all the various present-day hardness tests measure different sets of properties. The term "sets of properties" is used advisedly because a single type of hardness test such as the indentation of a steel surface with a diamond point may involve many properties such as compression, shear, slip, fracture, etc. To make matters bad, the relative amounts of these properties may vary as the test progresses. And to make matters still worse there is, as Williams himself has said, no known method of hardness testing (even magnetic methods) which do not change the hardness of the sample as the test progresses either by cold working, magnetic working, etc. This reminds one of quantum measurements in the remote atomic realms in which the act of measuring defeats the object of the measurement. Such defeatism may be a characteristic of all measurements pushed to an extreme, but here one faces the problem in the realm of everyday practical measurements.

New tests for hardness are continually being invented, and many comparisons of the results of different tests have been made, but the problem can not be satisfactorily solved until the test elements are reduced to utmost simplicity and clearly defined. From such a viewpoint it appears that the problem of hardness is one in which the recognition of the value of the operational viewpoint is particularly desirable. Just as in the case of velocity and other apparently simple concepts, the concept of hardness can have no real meaning aside from the operations which have been performed. The operations performed here, however, are much more complicated than those of reading a clock and a scale of length to get a velocity, even though we recognize the relativistic complications in the concept of velocity. But here, though the operator may only turn a wheel or release a lever, the testing machine is itself performing a set of complicated operations. Take, for instance, indentation by a diamond point and consider the many elements as indicated above into which the apparently simple operations can be resolved. This manifold of operations must be understood if the measurement is to have meaning in terms of them. This is exactly the standpoint taken by Professor Williams, who without actually using the term operational viewpoint has spent many years prying into the multiplicity of operations which go to make up a particular hardness test. But the field is so large and the types of training which are needed are so varied in even apparently simple investigations, as the author has shown, that there is plenty of work for the future. Some idea of the amount of work already done can be obtained from the bibliography of approximately 2,000 references in Professor Williams' book.

The confusion in the past over the question of hardness has been largely due not only to the large variety of methods of testing hardness but especially to the conflicting viewpoints of metallurgists, physicists and others who are only now being drawn together by a clearer recognition of the fundamental principles involved. For instance, one example of a radically different viewpoint from that outlined above is the work of D. Landau, who by a method of dimensional analysis has arrived at a formula for hardness $H = CE^mL^n$ where H is a numerical measure of hardness; C is a constant; E is the modulus of elasticity; L is the compression elastic limit, and m and n are small positive numbers. Such a procedure may imply the existence of an absolute standard or it may set up an arbitrary standard which the formula approximates. But it implies that we know much more about the dimensions involved than we actually do and it neglects the operations on which a knowledge of such dimensions is based and which vary from one experimental procedure to another. Neither would the operations involved be easy to apply to a series of samples.

If workers in the field will recognize the fundamental character of the operational viewpoint a considerable forward step would be taken toward a common meeting ground for those workers of diverse interests, and widely different types of training whose views in the past have often seemed irreconcilable. But to further such a position it will be necessary to do much more experimental work in clarifying and defining the operations involved, excellent though the beginning already made may be.

ROGERS D. RUSK

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THE POSSIBILITY OF PREVENTION OF TUBERCULOSIS BY NON-POISONOUS CHEMICAL AIR DISINFECTION AND BY KILLED VACCINES

OF all diseases tuberculosis is one of the most common and also costly to handle, since it is relatively refractory to all known methods of treatment, except prolonged rest in bed. The great desirability of preventing this infection is therefore obvious, but meth-