Klein, on "Planck, Entropy and Quanta, 1901-1906", contains a very lucid treatment of the inception of the quantum theory. It is the author's thesis that: "If there is a single concept that unifies the long and fruitful scientific career of Max Planck, it is the concept of entropy." He goes on to show that, before 1900, Planck "attributed universal validity to the second law of thermodynamics" and had no use for Boltzmann's discovery of a relationship between entropy and probability. Between the years 1901 and 1906 Planck changed his views in this respect quite radically: "Within two years after his second paper on quanta, Planck had not only accepted Boltzmann's statistical interpretation of entropy as a useful idea, but had begun to build it into the very basis of his own thought." Another important aspect of this interesting paper is to show that whereas Boltzmann apparently had never attributed any deep significance to the proportionality constant k, relating entropy and probability, and never attempted to estimate its numerical value, Planck reconized immediately its importance and universality. He calculated its numerical value, and in this respect it is interesting to note that Planck's calculations of the numerical values of several fundamental constants were way ahead of their time. The "precision" of his calculations "was not to be attained by direct measurement for almost a decade". This excellent paper is very much worth reading, not only by the historically minded but by all those who wish to have a deeper insight into the fundamental concept of quantum theory.

A new translation of the Preface to Lavoisier's "General introduction to Chemistry" (1787) constitutes the third paper of the volume. It may not be known to physicists in general that Lavoisier was the one who established the currently used nomenclature in chemistry. Until his time, chemical terms were derived from inventions of the alchemist, and by the end of the 18th century, with increasing knowledge of chemistry, the proliferation of very odd terms made life for the chemist very hard. Lavoisier was the first to point out forcefully, in words borrowed from Father Candillac, that "we cannot think without words; that language provides us with a precise means of analysis; that a calculus is a language as well as a tool of analysis when it is entirely simple, precise, and capable of expressing efficiently what it sets out to express; and that the art of reasoning is basically the use of a properly constructed language". The whole "Preface" in the present printing is about a dozen pages long, and the second half of it is perhaps less interesting, but the first part is masterly writing, and the translator and editors of the volume are to be thanked for bringing it to our attention.

The last contribution is by William Alexander Kay and is entitled "Recollections of Rutherford". Kay was Lord Rutherford's laboratory assistant when he was Longworthy Professor of Physics at the University of Manchester. About seven years ago, Samuel Devons persuaded Kay (who was then nearly eighty years old) "to recount his personal recollections of Rutherford and his work along side him. These were recorded on tape, but . . . the diction was not always clear and Kay's attention wandered from subject to subject". The result of the transcription is much what could be expected from recollections of a very old man. The account is quite rambling and very disconnected. Some of the comments and interpretations added by Dr. Devons are very useful in making the recollections a useful addition to the growing lore upon Rutherford, and many who have known him personally will no doubt enjoy reading them.

Radio Astronomy. By J. L. Steinberg and J. Lequeux. Transl. from 1960 French ed. by R. N. Bracewell. 260 pp. McGraw-Hill, New York, 1963. $9.95.
Reviewed by H. J. Hagger, Albiswerk Zürich, Switzerland.

The young science of radio astronomy dates back to Jansky's observation of the background noise in short-wave communications and Reber's research in the VHF radiation of the sky; however, the astronomer's interest in electromagnetic radiation from space was aroused by van de Hulst's prediction of the neutral hydrogen line from interstellar matter and from experimental observation of this radiation. This book, written by two French radio astronomers and translated by a well-known US radio astronomer, is an excellent introduction to the field, stating the facts in detail, telling about the difficulties of interpretation of the experimental data, showing how useful radio astronomy can be as a supplementary tool to the classical, i.e., optical, observation techniques, and how powerful an instrument mankind is given to explore deep space.

The authors start with the role the atmosphere plays in radio observations, the description of thermal radiation of hot bodies, and the general properties and problems of simple radio telescopes, mentioning also the experimental tricks used to isolate radio sources from the noisy background. The fourth chapter is devoted entirely to interferometers and to the method of obtaining higher resolution power either by using multielement arrays or by a refined analysis technique. The experimental investigation of the important neutral hydrogen line is the subject of the next chapter. In Chapter 6, the mechanisms of emission of radio waves are dealt with, and here not only thermal emission is considered, but also plasma oscillations, gyromagnetic emission, interaction processes of charged particles with high magnetic fields (synchrotron effect), and Cerenkov radiation are taken into account for explaining experimental data. In Chapter 7, the radio spectrum of the sun is analyzed in detail, showing the relationship between optical observations and radio measurements. Thermal and nonthermal radiation from the solar system is the subject of the next chapter, and here facts and their probable explanation are given. Before the authors review the radio sources of our own galaxy, they trace a radio map of the Milky Way, showing how well radio astronomy is able to draw a picture of the physical events in our galaxy. Investigation of thermal radiation, of the hydrogen line, and of nonthermal radiation from our galactic system has filled the gaps of optical astronomy. In the last chapter, extragalactic sources are considered, radio sources which can give light to the better understanding

of events occurring in deep space, e.g., birth and death of stars in galactic systems, interaction between galaxies. Here, again, the Doppler shift of the hydrogen line is a powerful tool, especially when compared with the shift of the optical spectra. In their conclusion, the authors state that it is not easy to disentangle the most important contributions of radio astronomy to the understanding of the universe. Their book, however, can be highly recommended as a guide to the discoveries disclosed by radio astronomy.

Yankee Scientist—William David Coolidge. By John Anderson Miller. 216 pp. Mohawk Development Service, Schenectady, N.Y., 1963. $3.95.
Reviewed by R. B. Lindsay, Brown University.

The history of science is to a great extent the story of the men whose ideas and achievements have become a part of our scientific heritage. Hence scientific biographies assume an important role in education and in particular in the training of scientists. While no amount of reading about how great scientists tackled their problems can necessarily make a young person into a successful scientist, a good biography can provide valuable stimulus to the mind prepared to receive it.

William David Coolidge has had a long and eminent career as an industrial scientist, and it is highly appropriate that a biographical sketch of him should be made available. Mr. Miller has done a good job of providing this in the relatively short compass of 200 pages. At the same time he has added considerably to our understanding of the development of industrial research in applied science in the United States during the past sixty years.

The author traces in chatty style Coolidge's educational experience at the Massachusetts Institute of Technology, where he was a member of the class of 1896, and at the University of Leipzig, where he received his doctor's degree in 1899 with a thesis under Paul Drude on the dielectric constant of liquids. Back at the Institute in Cambridge he shifted to work in physical chemistry under Professor A. A. Noyes and stayed there until 1905, when Dr. Willis R. Whitney persuaded him to join the staff of the newly organized Research Laboratory of the General Electric Company in Schenectady. He remained in this activity for thirty-nine years, during the last twelve of which he served as director of the Laboratory.

Mr. Miller describes in relatively simple fashion Coolidge's researches on the production of ductile tungsten, his achievements in the production of high power x-ray tubes, and his First World War work in underwater sound. Ample attention is also paid to Coolidge's important contributions to better public understanding of the role of industrial research in the nation's economy.

This is by no means a profound and searching study, but it does provide an engaging picture of the trials, problems, and success of a distinguished scientist. It should be read with interest by all physicists.

Thermal Physics. By Philip M. Morse. 455 pp. Benjamin, New York, 1964. $10.50.
Reviewed by Bruce W. Shore, Harvard College Observatory.

As the title suggests, this book covers the disciplines of physics in which thermal properties are important—the subjects often treated separately as thermodynamics, kinetic theory, and statistical mechanics. It is intended for textbook use in a one-semester senior-graduate course that provides the necessary foundation for strictly graduate-level study in physics and engineering. Thus this text presents thermodynamics as an important tool for the physicist, rather than as an end of its own. The reader is constantly reminded of the many ways he will be building upon this subject in graduate study.

Many physicists are already familiar with the earlier "preliminary edition" of this work, published as a paperback (at $4.50) in 1961. The present hardbound "revised edition" is an expansion from 276 to 455 pages, bringing in important new examples and clarifying several sketchy points of the earlier edition. The number of problems was roughly doubled, to a new total of 123.

The text is divided into three main sections: Thermodynamics (ten chapters), Kinetic Theory (five chapters), and Statistical Mechanics (twelve chapters). Each chapter fits into a clearly defined plan, progressing from macroscopic properties of matter to a microscopic atomic description. Yet the author does not hesitate to inject atomic-scale examples frequently, using models that receive full discussion only later on, to show how macroscopic properties relate to atomic properties. A list of chapter titles does not do justice to the exposition, though it does indicate the approach. Very briefly, the thermodynamics section begins with basic notions—heat, temperature, and pressure—progresses to state variables and the first and second laws of thermodynamics, proceeds to entropy, followed by the thermodynamic potentials. The kinetic theory section starts from notions of probability and distribution functions, proceeds to phase space, transport phenomena, and fluctuations. (The previously brief phase-space chapter was expanded considerably in the new edition, and now gives a vivid picture of how points move in phase space.) The statistical mechanics section takes the information theory approach. It develops the various ensembles—microcanonical, canonical, and grand canonical—and proceeds to the quantum statistics of Bose-Einstein and Fermi-Dirac particles, stopping just short of the Boltzmann H-Theorem and cluster expansions.

This book is not intended as a treatise (it covers fewer specific applications than Landau and Lifshitz's *Statistical Physics*, for example), but it includes many interesting applications and illustrative examples. The new hardbound edition includes several important additions: it introduces entropy parameters and non-equilibrium thermodynamics as part of the discussion of the thermodynamic potentials, and it includes a much lengthier discussion of BE and FD statistics, a section on interparticle forces, and an excellent discussion of the properties of liquid helium. Among the other numerous examples which also appear in the preliminary edition, I might mention the