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PHYSICAL METHODS IN QUALITATIVE AND QUANTITATIVE CHEMICAL ANALYSIS

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During the first half of the present century one has witnessed a great expansion in the role which the physicist plays in the field of chemical analysis.

The instruments and techniques developed by the physicist for the determination of physical constants have furnished the chemical analyst with new devices which can be used for the quantitative and qualitative determination of the elementary composition of substances. These new methods have supplemented the classical methods of gravimetric and volumetric analysis which experienced their greatest growth during the nineteenth century. The physical methods have enabled the analyst to broaden the scope of analysis, since in many cases accurate measurements can be made without destruction of the sample. He is also able to analyze complex mixtures quantitatively, which previously would have presented almost unsurmountable difficulties. The analyst now has at his disposal physical methods which enable him to investigate problems of structure in organic chemistry, reaction kinetics, and even the biochemistry of living cells.

By absorption spectroscopy the analyst is able to identify components and to measure the amounts present in certain compounds or mixtures of substances. In absorption spectrophotometry use is made of the property of the absorption of electro-magnetic radiation by substances throughout the spectrum extending from the infrared region through the visible, ultra-violet, and x-ray portions of the spectrum to the gamma ray region. In each region of the spectrum appropriate instrumentation is necessary for the detection of that particular type of radiation.

Emission spectroscopy, while known for many years, has only recently acquired widespread use in providing rapid quantitative analyses. A new epoch in spectrochemical analysis occurred approximately fifteen or twenty years ago when high quality spectrographic equipment began to appear in many industrial laboratories. Previous to this time such equipment was found only in the research laboratories of the universities and the government. Bunsen and Kirchhoff in 1860 first used the spectroscope in performing a chemical analysis. The foundations for qualitative emission spectroscopy, however, were laid by W. Talbot in 1826, when he observed that the radiations, emitted by salts of potash and sodium in flames, experienced a definite refraction when passed through a glass prism.

Certain compounds with a special structure are capable of absorbing radiation at particular frequencies and re-emitting the energy at lower frequencies. Such substances are said to possess the property of fluorescence. This fluorescence radiation can be used in quantitative analysis, since the intensity of the fluorescence is proportional to the concentration in dilute solutions. The red fluorescence so apparent in chlorophyll solutions was first observed by Brewster in 1833. Sir G. G. Stokes in 1852 was able to show from his studies of the fluorescence that chlorophyll

consisted of a mixture of two pigments. The spectroscopic equipment of Stokes consisted of a glass prism used with the naked eye.

The mass spectrograph is another instrument developed by the physicist which has recently found a place in the field of chemical analysis, especially in the laboratories of the petroleum and rubber industries. In the quantitative investigation of reactions where stable isotopes are used as tracers, the mass spectrograph is the indispensable instrument.

Recently a tool which the physicist has furnished the chemical analyst is in the field of radioactivity. The analyst is able with the proper equipment to follow in a quantitative fashion chemical reactions which could not be traced by any other method. The most recent addition to the field of quantitative analysis is the use of neutrons. The development which this field received during the recent war period has opened new areas in analytical work the extent of which cannot be predicted.

A symposium on "Physical Methods in Qualitative and Quantitative Analysis" was held under the joint sponsorship of Section F of the Ohio Academy of Science and the Ohio Section of the American Physical Society at Miami University, Oxford, Ohio, April 6, 1951. Its purpose was to bring together the research men from the industrial and academic laboratories to consider the progress that has been made in a borderland field in which the results of physical research have played an important part. The following six papers were presented as a part of the symposium: "Emission Spectroscopy in the Steel Industry" by E. R. Vance; "Absorption Spectrophotometry" by D. L. Timma; "Analysis Using Infrared Spectroscopic Methods" by Robert A. Oetjen; "Chemical Analysis by X-Rays" by C. H. Shaw; "Analytical Applications of Mass Spectrometry" by D. R. Lawler; "Radioactive Methods of Analysis" by G. D. Calkins.
