

THEORETICAL CHEMISTRY

(Continued from page 41.)

the important principles of theoretical chemistry and on their illustration by numerous applications. In these subjects, however, the principles are necessarily considered disconnectedly, interspersed with much descriptive material, and as a rule their qualitative aspect can alone be discussed. Therefore in the third year of Course V, and the fourth year of Course X, a course specifically entitled Theoretical Chemistry is given in which the general principles of chemistry are connectedly presented and their quantitative side is developed. It is this course which it is the purpose of this article briefly to describe.



PROF. A. A. NOYES.

The course includes ninety class-room and fourteen five-hour laboratory exercises, both extending throughout the year. The class-room work consists almost wholly in the solution of problems by the student. Any principle that is to be discussed is stated and explained by the instructor and a number of problems involving it are then assigned. The solutions of these problems are handed in at the next exercise and are then worked out in the class-room by the students under the guidance of the instructor. Frequent half-hour tests consisting mainly in the solution of new problems are given. Lecture experiments are presented with the purpose of making sure that the student has a practical understanding of the conceptions and quantities involved in the laws under consideration. The laboratory course has also the same purpose in view; it is not intended to teach methods of measurement, but to give the student a concrete appreciation of the phenomena that are being discussed in the class-room.

The plan of the course is to consider only a comparatively few principles, those of the greatest importance being of course selected, and to emphasize these by numerous and varied applications. In this way a thorough knowledge of the more fundamental laws of chemistry is secured rather than a superficial acquaintance with a wider field; and (what is even more important) opportunity is afforded for a continuous training in logical thinking and for developing the power of solving scientific problems. The final examinations are almost wholly a test of the degree of this power rather than of the knowledge acquired.

The subjects most fully considered in the course are the laws relating to the following phenomena; the pressure of gases, the vapor-pressure and other properties of solutions, the electrical conductivity and ionization of substances in aqueous solution, the rates and equilibria of chemical reactions taking place in gaseous mixtures, in solutions, and in systems involving also solid substances, the laws of thermodynamics, the heat produced by chemical changes, the effect of temperature upon their equilibrium, and the development of electricity and electrical energy by chemical processes.

For more advanced study and research in theoretical chemistry facilities are afforded by the Research Laboratory of Physical Chemistry, which is described in the following article.

THEORETICAL LABORATORY

By A. A. NOYES.

This Laboratory, established by the Institute in 1903, is devoted to advanced study and research in theoretical and physical chemistry. The investigations are carried on in large part by a salaried staff of research associates and assistants; but its facilities are also offered to instructors from other colleges and to advanced students who wish to engage in physico-chemical research, whether with or without reference to one of the higher degrees, Master of Science or Doctor of Philosophy. The latter degree has been conferred by the Institute in the past two years upon six candidates from this laboratory.

In addition to the complete courses in physical chemistry and electro-chemistry offered by the Institute, a number of advanced seminars are held under the direction of members of the research staff. These are supplemented by weekly conferences for the discussion of investigations in the laboratory and of current publications.

The excellent equipment of the Laboratory and the services of a skilled instrument-maker permit the study of a very wide range of experimental problems. During the past few years investigations have been carried on in almost every branch of physical chemistry and electro-chemistry, and forty-six articles describing them have already been published.

INDUSTRIAL CHEMISTRY

By F. H. THORP.

In connection with the course in Industrial Chemistry, a travelling Summer School has been held several seasons. During a period of about two weeks, in June of each alternate year, a party of students from the courses in Chemistry, Chemical Engineering and Electro-Chemistry, has visited a district where various manufacturing industries could be inspected while in operation. Attendance on these trips has been entirely voluntary, each member of the party paying his own expenses, but all sharing in the reductions of hotel and railroad rates, obtained in consequence of travelling as an organized party. In order to relieve the Institute of a part, at least, of the financial burden, it seems desirable to charge a small tuition fee, which is to some extent contingent upon the number joining the party.

The number is limited, both as to maximum and minimum; with too large a crowd, the men get into each other's way in the factory, making it difficult to clearly understand what is shown; moreover, hotel accommodations become difficult to arrange. On the other hand, it is felt that too small a number would not be a creditable showing for the Institute, with its known large classes, and would hardly justify the large amount of work necessary to arrange for these excursions. Experience has shown that from a dozen to fifteen is the most satisfactory, and more than eighteen or twenty should not be taken.

Evening conferences are held, at which the various processes and plants seen during the day are discussed by the members of the party and the professors in charge, with the purpose of clearing up obscure points, in the processes observed, and of comparing the theoretical and practical economics of manufacturing.

It is not intended nor expected to learn the private formulae nor secret methods of any manufacturer; but a general idea of the magnitude and importance of the several industries will be gained and some comprehension of the great practical differences between laboratory experiments and manufacturing as carried on in a large way. The notes prepared upon these trips may prove of much use in yielding ideas later in the student's practice, even along lines totally different from the industries visited. In any case, the actual value of this Summer School cannot be estimated in money, and no man can take a serious part in it, without deriving material benefits.

MUST ANALYZE FOOD

Importance Of This Work Grows With Increase Of Frauds

By PROF. A. G. WOODMAN.

Of the three essentials for healthful life, air, water, and food, the last named is perhaps not the least important. Air and water are of little use to the system if the food consumed cannot through their aid be absorbed and assimilated. Metabolism in the body is of doubtful value if the substances eaten irritate the tissues they should nourish. Improper and ill-balanced food may be as great a factor in lessening the resistant power of the body to encroaching disease as lack of food.

Examinations of food substances may be made in order to learn their nutritive or economical value, to fix standards of purity to which materials on the market shall conform, or to determine their freedom from falsification or adulteration. In all of these cases chemical analysis is the controlling factor.

Whether it be a question of the proper balancing of protein and carbohydrate to furnish a rational ration supplying maximum nourishment and energy, or the exposure of fraudulent claims regarding some widely advertised breakfast cereal, the food chemist renders the final decision.

The service which the food analyst renders to the public is extensive and exceptional. Claims of superior excellence, received with credence by the people, are shown to be baseless. The value of cheap foods, hitherto neglected, is pointed out, and their preparation and use exploited. Common and gross errors in diet are noted and the method by which to avoid them indicated. The greatest loss in efficiency of the human machine comes from ignorance and carelessness in disobeying the natural laws of food.

The passage of a Federal Pure Food Law has awakened the public conscience, and the food materials of the markets are, through the aid of the food analyst, being held to a strict account. With the government work, the laboratory of food analysis is in close touch, and its students and their work find an appreciative reception in the furthering of this official movement.

Food analysis at the Institute is given in two distinct courses, a brief elementary course, followed by a course in advanced food analysis.

In the elementary course, food analysis is undertaken from the standpoint of its educational value especially and typical methods are chosen as illustrative. The methods employed are in many respects different from those to which the student has been accustomed in his previous analytical training and the diversity of apparatus and operations has high educational value, and lends interest to the work. The laboratory work is supplemented by discussions of the leading principles of nutrition and food economy, graphically illustrated. Special attention is devoted to forms of food sophistication that are of doubtful physiological or hygienic value.

The more advanced course is planned for the training of those who wish to gain an idea of what may be expected of the food chemist in municipal or government service. To this end methods of food control as officially practiced are kept in mind and the student is in constant touch with the work of state and government laboratories. A wide range of work is considered, the student is expected to make extended studies of particular problems in adulteration and control, and to present in conference to the class authoritative reports on the results of his work.

Modern conditions in living and the sale in the markets of so much manipulated material make it necessary that a certain knowledge of the approximate composition and food value of common edible substances should be an essential of education. The special application of this branch of chemical knowledge has made rapid advances in the past few years, and with the impetus it is now receiving is bound to be an important factor in future educational growth.

ANALYTICAL CHEMISTRY

By PROF. HENRY FAY.

Analytical Chemistry is the tool by which the chemist accomplishes his work. It tells him of what a substance is composed and of how much there is of each component or element making up the whole. Chemical analysis consists of the systematic treatment of a substance or mixture with selected reagents in order to determine the singular components or elements by the phenomena accompanying this treatment. When the process is so limited as to determine the character only of the components it, is spoken of as qualitative; when it is pursued in such a manner as to tell the amounts of each component in the substance or mixture it is spoken of as quantitative. The primary purpose of analytical chemistry is to tell what a particular substance is and how much there is of it, and the subject is, therefore, divided into Qualitative and Quantitative Analysis.

To satisfactorily pursue either branch of analytical chemistry one must have received a thorough training in the fundamental principles and laws of general chemistry. He must have accumulated a knowledge of the laws and properties of matter, and of the elements of mathematics, and must have been trained to reason from cause to effect, and to observe minutely the characteristic properties of the elements and their compounds.

A course in analytical chemistry is invariably begun by a thorough training in Qualitative Analysis. This is best accomplished by first studying the characteristic properties and reactions of each of the common elements, and then by a study of the reactions which are common to certain groups of elements. By reason of the latter process separations of a group of elements may be made from matter, and having separated a group, then the components of this group can be further separated into smaller groups or into compounds characteristic of the individual elements. This process not only serves to identify each component of a substance or mixture, but, if intelligently carried out, to familiarize one with the properties of the many substances worked with, and to train the senses in accurate observation. The subject is begun with a study of the simple salt containing a single metal and base, and from this one is led to mixtures of salt, and complex compounds, and finally to the analysis of minerals, alloys and the infinite variety of industrial products. The study of qualitative analysis is not only essential to the chemist, the biologist, physicist, mining, and sanitary engineer, but is also useful to the engineering profession.

Quantitative Analysis is a more strictly professional subject, although used to some extent in its simpler forms by the engineer, and logically follows the course of qualitative analysis. During the second half of the Sophomore year the student is trained in the elementary principles of gravimetric and volumetric analysis. The choice of subjects for analysis is made so as to represent the various principles involved and at the same time to emphasize the application of analysis to industry in its simpler forms. During the Junior year, the more strictly professional training is carried on, and work representing the larger commercial interests is given. In this way the analysis of iron, copper, zinc, sulphur, and other ores, the silicate rocks and other minerals is made. This is followed by a training in iron and steel analysis, the methods of which are used as types of the rapid, accurate commercial work.

In addition to the work outlined above, which is so arranged as to illustrate the various principles underlying analytical chemistry, the student receives training in the more especial branches such as organic analysis, gas and oil analysis, and the analysis of air, water and food.

The object of the course is not in any sense to train routine analysts, but to train men broadly so that they may use this knowledge as a tool in working out the larger problems of pure science or industry.