or the new description of the Morgan gems, which is to present the finest combination of realistic accuracy and artistic beauty yet attained. GEORGE F. KUNZ.

Laboratory Exercises in Physical Chemistry. By FREDERICK H. GETMAN, Ph.D. New York, John Wiley & Sons. 1904. Pp. 241.

Laboratory manuals in physics and in chemistry separately have been put upon the market during the last twenty years in sufficient number to satisfy all reasonable demands on the part of the general public. But during this interval a field that overlaps both of these has become differentiated, the start being made by Ostwald, whose work has been taken up and enlarged by a considerable number of ardent workers. Many of the laboratory operations involved are not provided for in the current manuals in English. Ostwald's 'Physiko-Chemische Messungen' and Traube's 'Physikalish-Chemische Methode' cover the ground well in German, but, as is so often the case in German books, the amount of detail involved in the effort to be exhaustive, and the large number of references to researches not easily found in most American college libraries, deprive them of much of their value for American beginners.

Dr. Getman's admirable little book has been prepared with constant recognition of the American demand for directness and economy. His own experience during the last few years in Johns Hopkins University, where physical chemistry was the subject in which his doctor's thesis was prepared, has been linked on to several years of previous experience in the teaching of chemistry. His effort has been to select only such methods for presentation as he has found to be typical and worthy of preference. He has very decidedly the teacher's instinct, exhibiting much aptitude in the art of arrangement and of clear expression. Although the book is not yet two months out of press, it has been already adopted in a number of university laboratories. It certainly meets well the needs of the beginner in physical chemistry and is worthy of special commendation as a handbook.

The range covered may be briefly indicated. In the introductory chapters the author discusses the theory and use of the balance; volume and density; viscosity and surface tension; and the determination of solubility. Thermometry and calorimetry are then considered, and a chapter on optical measurements is introduced. This is followed by several chapters on electrical measurement of conductivity, electromotive force, current and the dielectric constant. The last chapter is on chemical kinetics as illustrated in reactions of the first order, like the inversion of cane sugar, and of the second order, like certain cases of saponification.

The book closes with a well-selected series of tables and an index.

W. LE CONTE STEVENS.

DISCUSSION AND CORRESPONDENCE.

THE USE OF ROMAN NUMERALS.

ROMAN numerals are frequently used to designate the volume of a serial in bibliographic references. Instead of writing Vol. 88, or merely 88 after the name of the serial, we go to the trouble to write LXXXVIII. Why? Simply because we have seen others do it, and have unreflectively imitated them. When we are forced to defend our usage we find that there are few reasons for the use of the Roman system, whereas there are many reasons for the use of the Arabic system. Those who are intelligently in favor of the Roman numerals in bibliographic work argue that the use of them enables us to avoid the abbreviation for volume, while at the same time we thus distinguish sharply between volume and part, or volume and page. They, furthermore, urge that it is well for us to conform to the usage of publishers. But these arguments should be considered in the light of the following facts.

Although no one would deny that it takes much longer to write and read the Roman numerals than the Arabic, and that we are far more likely to make mistakes in dealing with the former system, few of us realize how great the difference in the ease and accuracy with which we use the two systems really is. In order that my arguments for the use of Arabic instead of Roman numerals, not alone

in bibliographic work, but also in all cases where there is no clear advantage in favor of the more cumbersome system, might have the support of quantitative data I have chosen ten well-educated, and in most cases scientifically trained individuals, and determined for each the time necessary for the writing of the Roman and the Arabic numerals from 1 to 100 and the number of errors made, also the time necessary for the reading of the Roman and the Arabic numerals from 1 to 100 when they were irregularly arranged so that the reader did not know what order to expect. In all cases the number of errors made unconsciously was recorded. These measurements furnish the following startling averages: *It takes three and one third times as long to write the Roman numerals from 1 to 100 as the Arabic, and the chance of error is twenty-one times as great; it takes three times as long to read the Roman numerals from 1 to 100 as the Arabic, and the chance of error is eight times as great.*

In case of a quick and accurate mathematician, whose familiarity with the Roman system surpassed that of most of the individuals tested, the results were: time for writing Arabics, 107″, errors, 0; time for writing Romans, 357″, errors, 5; time for reading Arabics, 62″, errors, 2; time for reading Romans, 131″, errors, 5. For one well-trained scientist, who has cause to use the Roman system almost every day, the number of errors in the rapid reading of the Romans was 15!

These figures certainly indicate the desirability of using the Arabic system wherever there is no urgent need for the simultaneous use of two or more systems of numerals. Even if there were no saving of time and strain by the avoidance of the cumbersome Roman symbols, the far greater accuracy gained by the use of the Arabic system should at once settle the matter for all scientists.

Robert M. Yerkes.

Harvard University.

[The best usage in bibliographic work is to use heavy-faced Arabic type for the volume number. The number should be underlined in the manuscript with a waving line, and it will then be set in heavy-faced or block type by the printers. This usage we think originated in American botanical publications. The volume number in heavy-faced type is followed by a colon and then the page numbers are given in ordinary type. The date or year then follows after a period, though we should suppose that a comma would be better. The International Catalogue of Scientific Literature has adopted the heavy-faced type for the volume number; this is followed by a comma and the year, the page numbers being then given in parentheses after another comma. We think that the American usage is the better and should be pleased if our contributors would follow it. The pages of the International Catalogue are disfigured by hundreds of thousands of needless parentheses and periods.—Ed.]

SPECIAL ARTICLES.

PUPATION OF THE KELEP ANT.

The larvæ of ants share with those of butterflies and moths the habit of spinning cocoons in which their transformation to the adult form takes place, though not all the ants make cocoons. Lubbock states that 'as a general rule, the species which have not a sting spin a cocoon, while those which have are naked,' the implication being, apparently, that less protection is required by species having stings with which to defend themselves. It would seem, however, that the absence of the cocoon rather than its presence is to be looked upon as the adaptive character. The keeping of the insects from drying out during the inactive period of transformation is probably a more important general function of cocoons than that of protection against enemies, but the moist underground chambers and compact social organization of the ants have rendered cocoons unnecessary, and in many genera they have been dispensed with.

The family Ponerida to which the kelep*

* The kelep has been identified by Dr. Ashmead and Mr. Pergande as *Ectatomma tuberculatum* Oliv., a species widely distributed in tropical America, including Mexico, and hence the more likely to become established in Texas. It does not follow, however, that the instinct of attacking the boll-weevil is possessed in an equal degree by