secondary schools. It is hoped that each of these subjects will be discussed very thoroughly. Naturally the latter, being the larger subject, will be the more fruitful in matters for consideration. The general questions which will be raised will be: What subjects, if any, all children should at first study in common; whether the training should not in all cases necessarily include literary instruction and practical instruction (science, drawing, manual and physical training, etc.); and how far up in the schools both these should be carried. Then will be considered at what stage, and to what extent, divergence from the general preparatory courses should take place, and the best curricula will be discussed for schools preparing for (1) commercial professions, (2) domestic professions, (3) engineering and applied science professions and (4) literary professions. Finally the relation in such schools between literary and practical branches of instruction will be dealt with. Besides discussing these important questions, the section will consider the reports of various committees on subjects deserving of careful attention. Four reports will be presented, relating to the conditions of health essential to the carrying on of the work of instruction in schools; the teaching of natural science in elementary schools; the influence exercised by universities and examining bodies on secondary school curricula, and also of the schools on university requirements; and the teaching of botany in schools. This last, as has already been stated, is the report of a joint committee of Sections K and L. Reference, too, has already been made to the meeting which Section L is to hold jointly with Section E for the purpose of discussing the teaching of geography.

HIGH SCHOOL CHEMISTRY IN ITS RELATION TO THE WORK OF A COLLEGE COURSE.[*]

The object in discussing a subject of such latitude as the one assigned me I assume to be to suggest questions, invite criticism and point out defects rather than merits. Two distinct questions claim our attention in discussing the relation of high school chemistry to the work of a college course.

1. Who ought to decide what is the most suitable course for high schools, and how shall such decision be arrived at?

2. What is the most notable defect in the present arrangement and what is the remedy?

I shall also assume that the young man preparing for college should study chemistry by the same methods as the one who is to be a farmer or a merchant. Whatever method is good enough for one is none too good for the other. As the elements of reading or arithmetic are taught alike to the future mechanic and elocutionist or accountant, so differentiation in chemistry should begin with the higher branches only. The question is to find the best system for teaching the science. That question, however, being a matter of individual opinion, is subordinate to the one I purpose to discuss. Who shall be the arbiter and how shall decision be reached?

The methods of yesterday are not the same as those of to-day, and to-morrow will bring its own differences. A generation ago chemistry was taught by recitation and lecture work. Now the laboratory supplements and in some cases supplants these. All new methods tend to extremes; hence those in vogue to-day are not necessarily nor even probably better in every respect than those of

[*] Read before the Science Department of the National Educational Association, Boston, July 10, 1903.

yesterday, though they may have elements of superiority. A method, for example, which discards entirely the text-book, which does away with recitation, which omits theory, may have some excellent points, but as a whole it is abominable.

In former years it was the custom of college authorities to state the subject matter and largely the methods to be used in the high school which offered preparatory subjects, and other high schools made their own courses. At first this seems eminently appropriate, for the student must be prepared to take up such work as the college offers, at a given indicated point. The college, in that view of the case, rightfully dictated the work for secondary schools. The governing body of each institution was entirely distinct from that of the other, and the only harmonious articulation of the two was the arbitrary 'requisites for admission' to the college, and these differed with different institutions; hence a babel of courses, methods and results. With the growth in the western and central states of state universities, the gulf between high schools and colleges was more easily bridged. But in the east other forces have been at work. Cooperation—the organizing of associations for the teaching of history, English, physics and chemistry, associations in which college professors and high school teachers meet and together discuss methods and formulate systems—has been a powerful factor in bringing into closer union the two classes of institutions. 'Community of interests' is found as desirable here as among railroads, and it stamps our science teaching with twentieth century methods. It is a splendid illustration of this harmony that high school teachers are invited to speak on the same platform with college professors and university presidents, to discuss a common subject. It emphasizes what a few years ago was not so fully recognized, that high school teachers as a class are not a whit less conscientious, nor perhaps in a majority of cases less qualified for the work they have to do than are their college brethren for theirs.

I believe that colleges can not long afford arbitrarily to say, without consultation of secondary school teachers, that just so much ground must be gone over by just such a method, nor can the high school unadvisedly lay out its course. What can high schools do as feeders of the college? What ought they to be expected to do? Such vital questions can best be answered only by conference and cooperation; for while the professor may know far more of the objective intricacies of the science, he can not understand as the high school teacher does the subjective emanations from the gray matter of the boy's brain and how best to direct those emanations. What is the history, what the tendency of cooperation?

The first club of chemistry teachers known to the writer, for comparing methods of teaching, was the Boston Chemistry Teachers' Association, formed in 1891 at the suggestion of Miss Laura B. White. This club has been in existence ever since and continues to hold monthly meetings during the school year at the Girls' High School in Boston. It is an informal club without organization, but it has done much effective work.

The New England Association of Chemistry Teachers was organized in 1898, by about a score of teachers of the science. The association has grown to not far from 100 members scattered literally from Maine to California. Printed reports of the three meetings per year give full details of papers and discussions and are distributed to each member, besides which occasional records of chemical literature, books and articles are issued. So far as known to the writer, this is the oldest, and to the

present time the largest, organization of its kind in this country. Recently several other societies of a like sort have sprung into existence, one in California (the Pacific Coast Association of Chemistry Teachers) and one in New York state, while inquiries concerning the conduct of our association from western states indicate that others are in process of formation.

These organizations which are sure to increase in numbers and efficiency, will do a great work towards unifying chemistry teaching. It is to be regretted that thus far the high schools are doing the major part of this work. I believe the only organization which can remotely approach to the ideal is that in which both college and high school teachers take a common interest, and enter into the work with equal zeal. In establishing chemistry clubs, therefore, care should be taken that no one class of teachers forms the active membership to the exclusion of the other.

Other associations of chemical workers have grown up, especially as adjunct societies to the large educational organizations of the country, among which the National Educational Association stands preeminent. I need not refer to the science clubs which are a feature in every large college, nor to the American Chemical Society nor the American Association, for these are mainly concerned with research work and facts, rather than with teaching.

But the organization which is doing more than all others at the present time to articulate high school and college work is the College Entrance Examination Board. Originating in 1899 at a meeting of representatives of colleges and universities of the Middle States and Maryland, it has grown so as to include twenty-three institutions, and the second annual report states that of all the colleges and universities in the United States only one declines to accept its examinations for entrance, three of which have already been held. In such a concentration of forces there is enormous saving of time and a unification of college preparatory work.

There is a second relation which I wish particularly to emphasize in our discussion. Many of our high schools give a fairly good course in general chemistry—experiments, theory and principles—some taking two years and including qualitative analysis, and a little quantitative work. Yet in a great majority of the higher institutions the work must be repeated.

To be obliged to go over again in college the preparation of oxygen, the properties of sulphur, the compounds of iron, which he has already studied experimentally and theoretically, the student regards as a useless waste of time, and reasons that if he must take the subject in college he had better spend his time in the preparatory school on some other branch, the rudiments of which will not be repeated. Thus is high school chemistry placed at a disadvantage in comparison with other elective subjects.

Two sets of reasons are advanced for this failure of the colleges to recognize preparatory chemistry from the fitting school. First and chiefly, because in a majority of such schools the student does not go deep enough into general chemistry to warrant his taking up at once the higher branches—quantitative or even qualitative analysis. He has not had theory enough nor practise enough.

A second reason is that some students offer chemistry for admission, others do not. Hence there must be an elementary course in college for those who have not had the subject prior to entering, and into this class are also put those who have studied chemistry in the schools. Thus side by side in the laboratory, taking also the same lecture notes, are those who do

not know an element from a compound, and those who have passed the searching college-entrance examination.

Wishing to know what is the actual practise in the higher institutions. I sent to each of the twenty-three colleges and universities that contribute to the College Entrance Examination Board, the following among other questions: 'Are those students that have passed elementary chemistry on entrance obliged to take general chemistry again if they continue the subject, or may they go on at once with more advanced work?' The College Entrance people were selected because they are united on a definite object, and are supposed to allow candidates for admission to offer chemistry. The result would probably not vary much if other colleges had been interviewed. Of twenty-three replies to this question (for every one answered it) seventeen are to the effect that the subject must be repeated, though a few say that if the course has been as thorough in the high school as it is in the particular college, the student may go on, implying at the same time that this rarely, if ever, happens. In two cases chemistry was not allowed as an entrance elective. One states unqualifiedly that students may go on, another that they may, but that very few continue the subject. Thus the almost unanimous verdict is: *Repeat.* And the offense with which the high school is charged is *inadequate preparation.*

Wishing to get at the evidence which weighed in the minds of the judges, I put to the same twenty-three institutions this question: 'In what part of the work do you find those offering chemistry most deficient?' To this question fifteen direct answers were given, and as they form the important evidence on which my client is convicted, I quote them.

ANSWERS.

1. Elementary general principles.

2. A comprehension of underlying principles. Pupils acquire facts but do not understand their relation to general principles.

3. Want of application.

4. Work is not thorough; mostly taught from books, ground covered too great for time devoted to it.

5. Elementary logic. Students coming to college are very deficient in reasoning.

6. Equations and laboratory work.

7. Making, putting up and using apparatus; a thorough knowledge of the non-metals; quantitative experiments.

8. Their failings will vary with the instruction they have received.

9. In general.

10. Perhaps theoretical more than descriptive.

11. Have generally 'done' a large number of experiments, but are sadly deficient in chemical laws.

12. In theory and in knowledge of metals.

13. Equations and familiarity with fundamental principles. Three fourths of the time at high schools is wasted in trying to cover too much ground.

14. They fail because they will not study, and I think in many cases they were never taught how to study.

15. The fifteenth and last is a venomous arraignment of high schools, untrue as it is unkind. Its author says: "The preparatory schools are not in a position to give students anything like the comprehensive instruction in elementary chemistry. In the first place, they can rarely afford to hire a chemist to give the instruction. They only get a school teacher who has a smattering of chemistry, and not a real chemist. In the second place, they never have much apparatus, so at best preparatory chemis-

try does not amount to much. The student does not get enough of it to amount to a row of pins. Now, on the other hand, the university professor begins at the beginning. He can not skip oxygen or hydrogen or nitrogen or water or the atmosphere because the students have heard these names once or twice in school,'' etc.

Such a scathing anathema, besides degrading the high school teacher's work, and elevating to the pedestal the university professor's, shows ignorance of high school chemistry as taught to-day. Hundreds of these schools have as teachers graduates in chemistry from colleges and technological schools, and scores have degree men from German and American universities who are 'real chemists,' and whose work compares favorably with that done in college. Again, it is the exception that high schools now building and recently built are not well equipped with laboratories. Within ten miles of this spot there is a high school chemical laboratory on which there was laid out for repairs alone last year more than $10,000, and another high school plant in the same city whose original cost more than thirty years ago was $40,000. Two weeks ago, happening to be in a city of only 25,000 people, in another state, I visited a high school laboratory better equipped than any college laboratory doing the same grade of work that it has been my fortune to examine.

This statement might have been true twenty-five years ago; it is probably true now of some remote country high schools. Its iteration by only one out of twenty-three shows that most colleges recognize the improved conditions in high school work.

Yet from these replies of representative higher institutions there seems no doubt that preparatory schools are trying to do too much and are really doing too little. Where is the fault, and what is the remedy?

A majority of the replies state distinctly that the deficiency is in laws and general principles; that students can not sufficiently correlate facts and theories. The teaching of laws, general principles and chemical theory assumes, therefore, paramount importance and constitutes the great desideratum. Elsewhere I have dwelt upon the importance of theory teaching, and the verdict of these colleges is a convincing corroboration.

While the inculcation of principles and laws is acknowledged by every instructor to be the most difficult part of his work, something to be avoided by the easy-going teacher and slothful student, yet it is recognized as the only thing that can give a broad grasp of the subject and, with requisite experiments, yield the largest results. The tendency in some quarters to omit the application of these broad principles, to abolish the text-book, to abuse the laboratory by excessive use to the exclusion of recitation and lecture, should be viewed with only temporary alarm, for such abnormalities will finally right themselves when the ideal course is adopted.

Entering college on chemistry is a comparatively recent thing. The colleges are the pacemakers, and the high schools are trying their best to keep up.

In the elective system that subject must take the place of so much mathematics, or some ancient or modern language. To be the equivalent of any one of these, a great deal of ground must be covered—the nonmetals and the chief metals, laws and general principles, the chemical theory including nomenclature, symbolization, etc. The fitting schools have tried to cover all this extensive ground, and, as most of these schools give but one year of three to five hours per week to chemistry, the result has been—to borrow Mr. Morgan's phrase of 'undigested securities'—a vast amount

of *undigested facts.* Little wonder the students are deficient in 'elementary logic,' in power of 'application,' and that 'their failures vary with the instruction they have received,' or failed to receive. The colleges, on the other hand, have set examinations to fit a one-year crammed course and have admitted students that were confessedly unable to go on with the higher branches of the subject, and were thus forced to repeat in a more thorough manner the work of the preparatory school. This unnatural loss of time and energy can not long continue in a quickened educational atmosphere. Two roads lead out of the woods. Let the authorities explicitly state that thorough preparation in the entire field of general chemistry can not be had in less than two years of five hours per week in a well-equipped laboratory. Make the examination rigid enough to meet this demand, and when the student has entered college, do not require him to repeat his work, but give him advanced standing, as he would have in Latin or mathematics. This is one road. The other, and I believe better one, is: Limit the requirement to one year's work; cut out the consideration of metals except as they incidentally appear in salts and acids radicals; demand a thorough course in the non-metals, the chemical theory, laws and general principles. Then, as in the other case, do not ask the student to waste another year or half year in repetition, but give him advanced work, beginning with metals.

Either of these plans would relegate the rudiments of the science to the high schools as is fitting. Why should the college teach high school chemistry any more than high school English, or high school algebra? I believe it is *almost,* if not altogether, as important that every high school graduate should know something of the composition of the air he breathes, the constituents of the food that nourishes him and the reactions of the fuel that keeps him warm, as to know the binomial theorem or the proof of the *pons asinorum.* Why require the latter as a prerequisite to entrance upon a liberal education, and omit the former? When colleges take the same stand concerning the fundamentals of chemistry which they assume in English and in mathematics, a great advance will have been made. As Cæsar is read in a preparatory Latin course, and not again studied in college, let oxygen, carbon and silica be relegated to the secondary schools, and the college course begin with metals, analysis, etc. This division line is purely arbitrary, but it serves my purpose of illustration. Any other division mutually agreed upon by conference of representatives of the two classes of institutions would serve equally well. I believe it to be entirely practicable for a conference of college and high school men to lay out a course with experiments to cover the required ground so satisfactorily that no repetition shall be needed.

I believe this subject is worthy of the most serious consideration from an economic standpoint. Last year President Butler gave an address before this association on the waste of time between the primary school and the university, and this week the discussion has been renewed under other forms by the college presidents. Right here is our chance for contribution. Save a year in chemistry. I believe it to be the plain duty of colleges and high schools to cooperate in formulating such a plan. Especially it seems to me that a strong point can be scored by the examination board that has undertaken the task of unifying entrance examinations and preparatory work, of setting a model which the high schools shall attain unto, in order that a

year of school life be not lost, that the student may begin in college where he leaves off in the high school, with preliminary work reasonably complete and satisfactory.

Rufus P. Williams.

SCIENTIFIC BOOKS.

Municipal Public Works, their Inception, Construction and Management. By S. Whinery, Civil Engineer. New York, The Macmillan Company. 1903. 8vo. Pp. 241. 8½ in. by 5¾ in.

This is an excellent book on a subject which is more and more attracting the attention of the general public. It is written by an experienced engineer 'for the inexperienced city official and for the urban citizen.' Although it treats of engineering subjects it is not a book of engineering. It is rather a book of public policy in municipal engineering affairs, and as such it differs from many books which have recently appeared with similar titles.

The early chapters in the book are elementary, describing the scope of municipal works, the relation to them of the engineering departments and the manner of financially providing for their support. The author then takes up the question of contract work, and discusses various details of it, such as advertising, preparing specifications, opening bids, awarding contracts, supervising the work, etc. He favors contract work as opposed to work done directly by the city, but points out many weak points in the ordinary contract. Contractors he divides into three classes—the honest and responsible contractor, the irresponsible and unreliable contractor and the boodler; and his descriptions of the conditions which operate to develop these different individuals are most instructive. He is strongly opposed to the compulsory award of contracts to the lowest bidder, and believes that in this, as in many other matters, the engineer or the commissioner should have more latitude and be held personally responsible for the result. In some of these matters the author is at variance with present custom, his theory being, apparently, that there is less chance of bad results due to the use of autocratic power by an occasional dishonest or unfit official than by the operation of laws which continually hamper honest officials and which are ignored or broken by the dishonest ones.

Perhaps the most valuable portion of the book is that which relates to the financial side of municipal works. The subjects of guarantees, special assessments, uniform accounts, municipal ownership, quasi-public corporations are treated in special chapters. His criticisms of the ordinary methods of municipal accounting are severe, but none too severe, as any one will admit who has attempted to compare the cost of any class of municipal work for different cities. And he is quite right when he says that many questions of public policy are being to-day obscured because of false statements issued with no intention to deceive, but simply as a result of bad bookkeeping. Among these questions he places that of 'municipal ownership' of public utilities, and while not wholly deprecating the modern trend toward public purchase of private water works, electric light works, etc., he believes that such changes should be made only after a more complete study of all the financial elements which enter into the question than is usually given to it. His comments upon the proper treatment of such matters as maintenance, operating expenses, interest, depreciation, sinking funds, in connection with the valuation of private property are worthy of serious consideration.

Instead of the wholesale municipal assumption of public utilities he favors private ownership under suitable control, and in the last chapter he outlines a plan and offers it as a solution of this vexed question. He would organize all quasi-public corporations under a general state law, similar in its general features to the present interstate-commerce law, and would make the law 'so radical and far-reaching as to assume, within limitations, the absolute control of quasi-public corporations and of their relations between them and the municipal corporations.'

Whether or not the reader agrees with all the author's conclusions upon the questions