

have heretofore remained unexplored, and will be continued as long as important gaps in our knowledge of the ethnology of the coast remain to be filled.

The regions in which investigations are to be carried on offer many peculiar difficulties, as well on account of the severity of the climate in the northern portions of the district as on account of the multitude of tribes that inhabit these regions. While almost the whole of Siberia is inhabited by tribes akin in language and similar in type, the eastern coast is occupied by a variety of races. The same is true in America, where in the interior we find a vast sweep of country inhabited by one people, while the diversity of languages and races on the coast is almost incredible. A thorough study of all the innumerable dialects, of the customs of all the tribes and of the physical characteristics, will be required to bring order into this chaos.

The difficulties of this problem will be better appreciated when it is stated that between Columbia River and Behring Strait ten languages are found that are fundamentally distinct, and that these languages have 37 dialects which are mutually unintelligible. On the Asiatic side there are seven distinct languages spoken in at least ten dialects which are mutually unintelligible, but there may be more since our knowledge of the whole area is very meagre.

The problem of the relationship of the racial types is a very attractive one. The relations of the races of southern Alaska and British Columbia to the other North American Indians, although not quite clear, are certainly very intimate, since a gradual transition of the northwest-coast types to those of eastern North America can be established. On the other hand, their features show a decided resemblance with the Asiatic types, but the races which we find in northern Alaska are much more remote from Asiatic types than those further south. It

is, therefore, likely that extensive migrations have taken place in this whole area.

We know that great changes in the seats of population have occurred in the central parts of northern Siberia. The weaker peoples of southern regions were pushed northward and finally came to occupy the inhospitable shore of the Arctic Ocean. It will require long and patient study of the inhabitants and of the prehistoric remains of the whole region to unravel its ancient history.

Even after the time of the early migrations of races in this region there has always been opportunity for intercourse and for exchange of inventions and of other ideas. The forms of certain utensils are much alike on both coasts, thus favoring the theory that they have spread over the whole area from one center, but archaeological investigation must show how long these forms have been in use and if they were preceded by other forms of culture. The mythologies must be scanned with great care. There is no doubt that among the people of Siberia a constant interchange of tales and myths has taken place. There are indications that the current flowed across to our continent, and it will be the task of the proposed investigation to discover to what extent American and Asiatic ideas influenced each other.

The whole field of research is a vast one, and it is to be expected that the enterprise inaugurated by Mr. Jesup will lead to results which will clear up many of the obscure points regarding the early history of the American race.

THE NEW YORK STATE SCIENCE TEACHERS' ASSOCIATION.

THIS Association, which was organized last July in connection with the Buffalo meeting of the National Educational Association, held its first annual meeting in Syracuse, December 29th-31st, following the

holiday conference of the Academic Principals of New York State.

Tuesday evening, December 29th, President J. G. Schurman, of Cornell University, addressed a joint meeting of the three educational bodies convened in Syracuse; his subject was 'College entrance requirements and the High School curriculum.' President Schurman expressed a strong disposition to encourage more thorough science work in our high schools by accepting sciences in preparation for college, and outlined several preparatory courses in which science should form an important part.

The meeting of the Association opened on Wednesday afternoon with the following paper by the President, Professor Simon H. Gage, of Cornell University:

The Purpose of the New York State Science Teachers' Association and the Work it Hopes to Accomplish.

It is a source of congratulation that the Science Teachers of the Empire State are no longer to remain scattered and unorganized, but by association are to gain the encouragement and enthusiasm which united effort brings. That enthusiasm and efficiency are promoted by such organizations of science teachers is abundantly attested by the results gained through the efforts of the American Society of Naturalists, and the teachers of Illinois, Colorado, California, and of other sections.

An association like this makes it easier for the college and for the secondary school teacher to come together and talk over matters of mutual interest and concern. In these friendly consultations and discussions there will be a chance of finding out something of what is most desirable and what is practicable and possible in the schools each represents. And in these discussions it will not be possible to forget the children in the elementary schools, the great majority of whom come neither under the

training of the high school nor of the college, but must be content to get the best they can from the elementary schools to equip them for the struggle of life which stands so near them. What help have these a right to ask from the high school and the college? And then the great world of thought and action whose mighty stream, sooner or later, draws all into it, what does it demand? It is, after all, the final court which tries all alike, and puts each to the test whether he be a college graduate, high school graduate, pupil of an elementary school or one who has only his hereditary endowment of mother wit.

The signs of the times all indicate that the high school teacher is to be at least a college graduate, and the elementary school teacher a high-school graduate. If this is true, while the college has but few under its immediate instruction it determines the character of the high school, and in turn the high school determines the character of the elementary school. The college is then the intellectual guide of the land. Is it and has it always been a wise and sympathetic guide?

If we compare our times with those of 500 or even 100 years ago there will be found an immense difference, and science is largely responsible for this difference. Whether we approve or not, things are not as they once were; whether we designate the change as one of progress or decline, there has been change, the world is not what it once was. The modern citizen must adapt himself to these changes or be ground to powder in the struggle for existence or for preëminence. The professional man, if he is a physician, is a criminal if he does not know and apply the science bearing upon his profession; and the lawyer who has only the knowledge that the Middle Ages might have given him is soon eliminated from the race. It is with hesitation that I speak of the clergyman, but if he misrepresents na-

ture which he might know, and to which he so often reverts for illustration, how can he expect unhesitating acceptance of his words concerning the profound mysteries that all, even the most favored, must 'now see as through a glass darkly'? The artisan, farmer and business man cannot live as did their forefathers; and so from the professions, from all the people, there comes an appeal so earnest, so pressing, that we cannot choose but hear. If they suffer for lack of knowledge we must do our best to supply the knowledge. In place of lofty isolation, or worse, of indifference, we should give them the science we possess, show them the way it is gained, and how much there is yet to be gained, and thus make every boy and girl, and through them every man and woman, in our great State an observer or original investigator in science. This can come about only when real science is taught and studied, only when the fog of opinion and baseless authority are brushed aside and the pupils in the schools are brought in direct contact with nature, and there learn to appreciate and apply the scientific method so admirably stated by St. Paul: "Prove all things, hold fast that which is good."

Our Association ought not and cannot stop with the work of the high school. From the elementary schools most pupils must enter the labors of life; they make the bulk of the State, and a noble patriotism should lead us to do all we can for them. On the principle of self-preservation also such help is wise, for the work of high school and college alike have their foundations laid in the elementary school. As the college reaches down to help and encourage the high school, so should the high school reach down and help and encourage the elementary school, and thus will it come about that every child in the State will be brought into direct contact with nature, where he can experience for himself her inspiring and uplifting sympathy.

If this program is to be carried out the college must train its students and prepare them to take the true science, science at first hand into the high school, and banish therefrom anything savoring of sham. Then the college must honor its graduates by accepting for entrance the work in science of the high school on equal terms with other subjects taught by its graduates. To bring this about, I take it, is one of the duties of this Association. Thanks to the work of the American Society of Naturalists, and to the many able men and women who have worked for the same end, science work done in the high school is at the present moment recognized by a considerable number of colleges. See *SCIENCE*, December 25, 1896.

It is discouraging, almost prohibitive, for the college to say to the secondary school, when you reach the proper degree of excellence in your science work, the college will consider your appeal for recognition. Why cannot the college state fairly and explicitly exactly what the standard of excellence should be? and with equal fairness and justice say, when your students reach this standard we will accept them for entrance on the same terms as for other good preparatory work. No true friend of science would ask the college to admit students with a training in science inferior to that required in the older disciplines. Let the college make its standard as high as it will, but let it recognize the work that comes up to its standard, and thereby honor its own graduates who have so worthily brought the work of their pupils up to the high standard. Such recognition would put science on a fair footing with the other disciplines. It would encourage and inspire the teacher in the secondary schools and help to give his work a dignity and importance in the eyes of his pupils and colleagues which it can never have if it is not honored by the college. Men still respect and honor

what the college approves, and it is a part of our work to see to it that the college puts the seal of its approval on sound learning in science as well as on that of the other disciplines which it accepts for entrance to its halls.

It seems to me the way before us is clear. Changed conditions have brought new needs, needs that knowledge of science can alone supply. We should do our best to help our day and generation, and in giving it the help of science and the sympathy of nature I feel confident that we are doing right in every way. Science, taught as every true teacher will teach it, will help the students to gain an insight into nature, will bring them face to face with reality, with law and order, and certainly will form at least one element in a noble education. It will emphasize the old lesson that power over nature comes only by obedience to her, and by this obedience, which can come only through understanding, discipline is gained. By action in accordance with law which is understood, and by reflection comes culture. With this discipline and culture come large sympathies and a wide outlook upon the universe. There comes also the consciousness that, while the current of life and law is irresistible, man is a part of the mighty current and his will has its due share in directing it.

Professor Albert L. Arey, of Rochester Free Academy, introduced the topic of the afternoon in the following address :

The Educational Value of the Physical Sciences.

It needs no skilled observer of the recent progress in educational affairs to discover that we are rapidly approaching that utopian condition in which the system of education shall be a system in fact as well as in name, and in which the work of the secondary school shall end where the college work begins, or, if you prefer the idea in this form, in which every subject that is entitled to a

place in the secondary school shall be required for admission to some course in college.

As teachers of the sciences it is our duty to accelerate the progress towards this end by all means in our power and to retard it neither by strife among ourselves because of conflicting opinions nor by inaction because of no opinion; but rather, by studying the problems confronting us in the same judicial spirit with which we study those of nature, to seek out the truth, and by discussion of our observations and conclusions to speedily settle mooted questions among ourselves. Among these unsettled questions which we may profitably discuss is this: Which science shall be required for admission to college, if but one is required?

My own answer to this question would be, Physics; first, because of its fundamental character. Bacon long ago said that physics was the mother of sciences. The laws and facts of physics are necessary to the understanding of all other sciences; chemistry is becoming more and more a study of the transformations of energy, and the biologic group is tending in the same direction, while in geology a knowledge of physics is more necessary than in either of those mentioned. Without its aid the action of the grand forces which have moulded the earth cannot be comprehended. And, second, its cultural and informative values are at least equal to those of the other sciences. The logical order in mind-building, as in house-building, is to begin at the bottom, and therefore physics should be required for admission to college if but one science is required. I am aware that several societies of schoolmasters have discussed this question, and that in some cases they have reached the conclusion that some other science should be first. And I hardly expect my friends, the biologists, to agree with me, but friendly discussion leads to progress, and I hope that we

all desire to know the truth more than we desire the triumph of our own convictions.

Other unsettled questions relate to the methods of instruction to be employed in the several branches of science, and these are important.

The methods of teaching the languages and mathematics have been refined by accumulated experience and they are substantially uniform throughout the world, while the teaching of science is of comparatively recent introduction and the variety of methods employed is great; under these conditions uniformity of results in older subjects and great variety in science is what should be expected, and, other things being equal, it is what is obtained.

It behooves us then to accumulate our experience that we may determine upon and adopt *our* best method. The 'Committee of Ten' performed a valuable service in giving us the outlines of a method of teaching physics and chemistry, and most teachers endorse their recommendation, "that these subjects be taught by a combination of laboratory work, text-book and thorough didactic instruction carried on conjointly, and that at least one-half of the time devoted to these subjects be given to laboratory work;" but these directions are not explicit enough to prevent the teacher from doing poor work, even though he follows the suggestions to the letter, and we may profitably consider the objects and the possibilities of the subjects from an educational standpoint.

Properly taught, both physics and chemistry yield splendid mental growth; they lead to valuable lessons of law and order; their facts are important and useful, and they furnish a kind of manual training of a high order of merit. Without desiring to belittle the other possibilities, I shall confine myself to the discussion of the mental growth which may be derived from these subjects, for this is the true education, the culture

which remains to the student when the facts of the subject have long been forgotten. Although the cultural value of the sciences was not at once admitted when first claimed, and although we as teachers sometimes lose sight of this point, it is an easy matter to show, as Spencer has done in the first chapter of his 'Education,' that the mental growth which results from the proper pursuit of the sciences is beyond compare the best.

Furthermore, the amount of culture which may be derived from scientific subjects is not limited, as is that which may be obtained from other subjects. The longer one studies a language, the more expert he becomes in the application of the accidental rules of its grammar, and correspondingly less exertion is required for the solution of the somewhat similar problems in construction; but in science, while he becomes more expert in the application of the necessary truths which he assimilates as time goes on, he attacks more and more profound problems, and the mental activity increases; and he can never reach the end, for there are problems in nature which can only be comprehended by the perfect mind of the Creator. As Huxley says, we reach the summit of the mountain we have set ourselves to climb, only to find that it is but a spur of the greater range beyond. And now let us consider *what* faculties of the mind may be developed by the study of physics and chemistry, and how they may be best developed. Remembering that the mind is stimulated to activity in certain directions by frequent exercise in these directions, just as skill in following a trail was developed in the Indian, our question becomes: What opportunities do these subjects afford for the exercise of the mental powers?

Concerning the evolution of the ability to remember, little need be said. This power may be cultivated by the text-book and reci-

tation method, without experiments, without laboratory work, without apparatus, often without even understanding, but what a worthless reward is received for the effort. Our pupils come to the secondary schools with memories so abnormally developed that they have atrophied the interest in nature which each of them inherited, and have made serious inroads upon their reasoning powers.

Perception is rapidly and easily developed by laboratory work. It is the universal testimony of those who have conducted laboratory classes that the students learn to observe accurately and well, but this faculty is not necessarily exercised by either the recitation or the lecture method.

Faraday said: "Society, speaking generally, is not only ignorant as respects education of the judgment, but is ignorant of its ignorance;" and the cause to which he ascribes this state is want of scientific culture.

Herbert Spencer, in his 'Education,' says: "Every step in a scientific investigation is submitted to his (the student's) judgment. And the trust in his own powers thus produced is further increased by the constancy with which nature justifies his conclusions when they are correctly drawn." And he adds: "From all this flows that independence which is a most valuable element in character;" and Professor Bessey, in an address on 'Science and Culture,' delivered in Buffalo last July, says: "The proper pursuit of science should develop a judicial state of mind toward all problems."

Here is abundant evidence that the judgment may be cultivated by proper work in science, and that the student may acquire confidence in his own judgment; but this also can only be accomplished in the laboratory.

The cultivation of the imagination is another of the possibilities. Professor Carhart, in his address to the Science Department of the National Educational Associa-

tion, says: "It is no new thought that scientific study makes a draft upon the imagination." And this may be best accomplished in the laboratory, although in the hands of a skillful teacher lesser but valuable results may be obtained in the class room.

The class-room work may be, and generally is, so conducted as to afford training in deductive reasoning, such as is derived from courses in mathematics. The solution of problems in physics affords particularly valuable exercise of the mind in this direction if the problems are judiciously selected, but there is a great difference in the benefits derived from the different problems; for instance, to solve such problems as the following requires very little mental friction: "What is the pressure on the upper surface of a Saratoga trunk, 2 by 3 feet?" while the solution of the following problem will compel thought which yields valuable results: "An empty toy balloon weighs 5 g. when filled with 10 l. of hydrogen; what load can it lift?"

The repeated solution of problems based upon the same formula is not to be commended, since the operation soon becomes mechanical, and therefore of slight cultural value, but the skillful teacher can easily introduce some new point into each problem, if he keeps in mind the object of his work. Furthermore, the discussions of the class room may be so shaped as to afford practice in deductive reasoning; the application of theory to the objects of everyday life, the illustrations of the laws, principles and definitions, and questions like 'Account for the slowness with which ice increases in thickness over a pond,' are easily presented to the pupil so as to develop power in this line. The prevailing tendency is, I think, to spend too much time on this class of work, for this is the particular province of mathematics, and deductive reasoning is of less value than

inductive reasoning, because it leads to no higher intellectual level than that of the major premise. Every conclusion and every thought is subordinate to that with which we begin the process, while inductive reasoning proceeds to broader and grander facts, which tax the human mind more and more in the effort to comprehend them.

Now, let us consider in what manner we may develop power to reason inductively. In the lecture room the teacher may lead his class step by step through an inductive process, and he may receive evidence that they have followed him in answer to such questions as, "Why do you believe that magnetism is a molecular phenomenon?" or "Why do you believe that a body in motion will continue in motion indefinitely, unless acted upon by some external force?" But discipline in inductive reasoning is best obtained in the laboratory. It is not derived from such experiments as determining the coefficient of expansion of iron or measuring the resistance of a coil of wire. This class of work is similar to the work that a mechanic does in sharpening and repairing his tools. It may furnish useful manual training, but no such discipline as does the measuring the resistance of many coils of wire so selected as to furnish a line of argument confirming the laws of resistance. Neither do such exercises as the last possess any such value as do original researches; here the experimental method reaches its maximum value.

We thus see that laboratory work is necessary to the best development of the pupil's mind, and that the object of the laboratory course is not to discover laws and facts; not to prove that the book tells the truth; not the manual training involved; but its great advantage over other means of developing the mind.

We see also that class-room work may be made valuable and that it is necessary, because of the culture derived by the stu-

dents, and because of the opportunity which the teacher is afforded of guiding the students' mental processes, and this combination of laboratory and class-room work is the plan recommended by the 'Committee of Ten.' Let us call it the American method for the present.

If I catch the spirit of the method of instruction in science employed in the schools of Germany, it is expressed in one word—'Questions'—questions which lead the students step by step through their own thoughts to the facts and laws of the sciences. I am unwilling to admit that in the products of corresponding schools the German is superior to the American; but I believe that we may with profit combine the two phases, and that increased educational value will be found in experiments which are performed with a set of questions to be answered before the pupil. Not such questions as "What color is this gas?" but questions so shaped as to compel thinking and to guide the thoughts of the student. In many experimental sciences the directions for experiments are accompanied by questions, but most of them are intended to call attention to facts. What I insist upon is that the teacher have in mind the mental process to which the question will lead the student. In closing, let me say that I found the Regent's syllabus in physics altogether too long for this class of work, and I believe that many teachers who are ready to do this higher grade of work are now rushing through the long course, developing only the memory.

Last November, in his opening address as President of Section A of the British Association, Professor J. J. Thompson says: "I hope I may not be considered ungrateful if I express the opinion that, in the zeal and energy which is now spent in the teaching of physics in schools, there may lurk a temptation to make pupils cover too much ground. It is, indeed, not uncommon to

find boys of seventeen or eighteen who have compassed almost the whole range of physical subjects. Physics can be so taught as to be a subject of the greatest possible educational value, but when it is so, it is not so much because the student acquires a knowledge of a number of interesting facts as by the mental training which the study affords in, as Maxwell says, 'bringing our theoretical knowledge to bear on the objects, and the objects on our theoretical knowledge.'

"I think this training can be got better by going very slowly through such a subject as mechanics, making students try innumerable experiments of the simplest kind, rather than by attempting to cover the whole range of mechanics, light, heat, sound, electricity and magnetism." And he concludes by saying: "I confess I regret the presence, in examinations intended for school boys, of many of these subjects."

Discussion by Professor E. L. Nichols on the Teaching of Physics and Chemistry in the Secondary Schools.

One of the chief difficulties with which we have to cope in considering the subject of science teaching in the schools lies in the fact that the schools have to handle two distinct classes of pupils: The large class which is not going to college and for which the education in science received in the schools is all that they are to receive, and a much smaller class with which the science taught in the schools is preparatory to the further study of science in the college and the university.

It is most unfortunate that our high schools and academies are obliged to treat these two classes of pupils together instead of offering them entirely distinct courses of study. If physics and chemistry, for example, are to be accepted by the universities as entrance subjects alternative with mathematics they must be so taught as to have a disciplinary value in some degree com-

parable to mathematics. Now, the disciplinary value of mathematics is universally conceded to be exceedingly high.

It is unquestionably possible to teach science in such a manner as to afford excellent mental discipline, but in order to do so the teacher must be thoroughly up in his subject and he must have this continually in view as the prime object of the instruction which he is giving. For the larger class of pupils, on the other hand, to whom the courses in physics and chemistry offered by the schools are all that they are to receive, the object for which the teacher must strive is in great part to convey useful information. In a word, the two objects sought cannot well be united in a single course.

In spite of the fact that nearly all the principals and superintendents of schools with whom I have spoken upon this subject have held it to be impracticable to separate the pupils who are preparing for college from those whom the high school or academy is to afford the completion of their education, I feel compelled to lay down as a first principle that a thoroughly satisfactory substitute for the advanced mathematics now required for entrance to college can only be obtained by teaching science to those preparing for college in an entirely different manner, and indeed in different classes from those who are not preparing for the entrance examinations. Where no such division can be made it is at least possible to treat the science *primarily* with a view to its *disciplinary* or *truly educational* value.

It is scarcely necessary to say that all sciences are to be treated as laboratory subjects. No school course in physics or chemistry which consists in the reading of a text-book, together with recitations upon the same, can possibly afford a suitable preparatory course for college. Neither will such a course prove of any appreci-

able advantage to the class of non-college going pupils. It were in my opinion far better to exclude science teaching from the schools altogether than to teach it in this way. The plan very generally followed in our schools of accompanying recitations upon such a text as indicated above by demonstrations with apparatus performed by the teacher does not call for so sweeping a condemnation; yet let me say plainly that no such course can be regarded as an adequate entrance requirement.

In both physics and chemistry, laboratory instruction is to be regarded as the essential thing; this is to be accompanied, in so far as time may permit, by the reading of a text-book and by demonstrations on the part of the teacher. Since the time allotted to these subjects is rarely large enough to make it practicable to use two books—a text-book and a laboratory manual—the text-book selected should be one written with a view to the teaching of the subject by laboratory methods. It should combine the features of the laboratory manual and the ordinary text-book of physics in brief and clear form. With a good book of this kind the teacher who understands his subject will select certain experiments to be performed by each member of the class individually; others he will reserve for demonstrations to be performed by himself in the presence of the class. The principles illustrated by these experiments, which should be so selected as to demonstrate the laws of the science, should form the subject matter of recitations. The lower the grade of the pupils the more prominent should the laboratory features of the course be made.

I am aware that in our larger schools there are considerable difficulties in carrying out a program such as I have outlined. The chief difficulty is not one, however, which is confined to the teaching of science; the fact is, that in all subjects the

number of teachers is entirely too small in proportion to the size of the classes. The difference between the teaching of science and the teaching of other subjects is that in science teaching the attempt to cut down the teaching force, as is done in other subjects, leads inevitably to a complete failure. Such failure brings about too frequently the abandoning of proper science methods even where the teachers themselves are sufficiently well prepared in their subject to know what these methods are. If our school boards and superintendents and principles and teachers were equally honest in the teaching of other subjects they would feel compelled to abandon the teaching of these likewise. The increase in the teaching force demanded for the purpose of permitting the schools to offer satisfactory entrance requirement courses, therefore, is not an exorbitant demand; it is simply a demand which should be met in every department of school instruction. If the question of science teaching in the schools serves to bring this matter more forcibly than it has ever been brought to the attention of those whose duty it is to determine the teaching force in our schools a good work will have been done.

While first-rate work in laboratory teaching of science can not be done where the number of students to be handled by each teacher is very large, something may be done. It is, for example, better to have laboratory experiments carried on by the instructor in the presence of the class than not at all. It is much better to have laboratory experiments carried on by groups of students than by the instructor himself. The efficiency of the teaching increases as the size of these groups is diminished, and it reaches its maximum only when the groups are reduced to one or two, or at most three, individuals.

Laboratory practice for the schools is intended to serve a double purpose. In the

first place, to teach the pupil to observe; in the second place, to give him practice in the simpler methods of measurement. It may be laid down as a general rule that quantitative methods should be employed wherever practicable, and that experiments in which a precise and definite result is reached are always to be selected. The metric system should be introduced at the very beginning and should be used *to the exclusion of all others* throughout the course. The introduction of the metric system of weights and measures into practical life in this country, for which strenuous efforts are now being made in many quarters, can be brought about more rapidly by its use in the schools than in any other way. The only thing which interferes with its immediate adoption by the people lies in their unfamiliarity with it. It may be confidently expected that within a few years this system will be used by our postoffice departments, in pharmacy and in every transaction between the government and the people. The schools, however, by the exclusion of the teaching of other systems in arithmetic and in science, can further the reform more effectively than all other agencies combined.

Finally, let me say a word or two with reference to the laboratory equipment. This in chemistry is not a serious matter. In physics, on the other hand, we find a great variety of opinions. There are those who hold that the best instruction is that which is carried on without the use of instruments; that school children should be taught to construct with spools and bits of string the philosophical apparatus which they are to use. We find, as the other extreme, equipments for demonstration, the price of which would involve the expenditure of tens of thousands of dollars. The proper course lies between these extremes. There are certain standard instruments which should be in the possession of every

school laboratory for use in demonstration and in laboratory instruction. These are not excessively expensive nor is the number of such instruments very large. A balance with weights, an air pump of the very simplest form but properly constructed with accessories, a lantern for projection, a clock with pendulum, a metronome, thermometers, an abundant stock of glass tubing and of flasks and beakers, a galvanometer (which may be home-made), a simple resistance box, some lenses and prisms, a set of tuning forks, an organ pipe and a sonometer—these together with scales divided to millimeters, a micrometer gauge and a supply of cross-section paper will enable the properly trained teacher to give a very thorough course in laboratory instruction. Where the number of pupils to be handled is large it will be necessary to duplicate many of these instruments. Before the schools can hope, however, to offer science courses which will be acceptable alternatives for the advanced mathematics of our entrance requirement it will be necessary to have a sufficient number of teachers who are thoroughly trained for scientific work and suitably equipped laboratories. The demand of science as regards the number of teachers is not really greater than that of other branches, but it is more urgent, and the failure which comes from inadequate numbers is more disastrous.

Professor John F. Woodhull, of the Teachers College, New York City, referring to the one-year course in Physics, prescribed by the Regents of this State, explained that it was a compromise between the old twenty-weeks course and a better course which would require two years. It is to be hoped that the course will be further lengthened and made to include more laboratory work.

Dr. T. B. Stowell, of the State Normal School at Potsdam, urged the importance of instruments of precision in the class-

room. The charge that the sciences are not comparable with linguistics in educative value, by virtue of their inaccuracies, is not without foundation. If a student in Latin should be taught that the third personal ending of the verb is *t*, or some letter in that vicinity, the college entrance examination would disclose marvelous results. This is only a fair sample of the lax approximations accepted by the teachers of physics in much of their experimental work. No piece of mechanism is too exact to demonstrate physical law, especially if we are to demand that the colleges accept work in the sciences as equivalent to the languages.

An interesting discussion followed concerning the usefulness of home-made apparatus, both sides of the question being advocated. Dr. C. H. Sharp, of Cornell University, thought a well-equipped workshop should be one of the first essentials of every physical laboratory, and a means of providing many well-constructed pieces of apparatus. It was agreed, however, that the quality of the teacher is of higher moment than the apparatus, the good teacher being always superior to his instrument.

Dr. William Hallock, of Columbia University, stated that the 'new curriculum,' which goes into effect with the beginning of the year 1897-'98, permits the student to offer, instead of Greek, an equivalent in the physical sciences for entrance to Columbia. Hence this desirable step in the advancement of sound education is no longer untaken or un contemplated in this State.

Speaking as a teacher in college he advocated the early study of physics. Mechanics is particularly well adapted to the training of the young mind to see, to think, and to express itself freely. If the preparatory school can teach the scholar to see, to think and to express his ideas; certainly the instructors in college will be very well satisfied with such a preparation, and will have the work of the further cultivation of

science greatly facilitated. As a preparation for college it is not desirable that the student be initiated into the mysteries (?) of the ether and the electro-magnetic theory of light and other similar subjects; these, if ever taught, should be taught in college; recondite theoretical discussions are out of place in an elementary course; higher mathematics is also superfluous. It is possible to give a student a very comprehensive knowledge of even the more abstruse facts of physics without requiring a knowledge of mathematics beyond the rule of three. College professors have all been teaching elementary physics because their students came to them with no knowledge of science, but with a loose way of thinking and writing, which is very hard to correct at that stage of their mental development.

As a general educational course for those who do not go to college, the course in physical science is of undisputed value. Here also the mechanical-physical side is preferable to the chemical side, as being simpler, more easily grasped, and more readily and generally applicable to everyday experience. The necessary apparatus is not extensive, complicated or expensive. The course should include a well-selected series of experiments which should tend to a gradual development of the powers of observation, of thought and of expression, rather than to instructing the student in all the latest and most remarkable discoveries of science. If he has the desire and has once acquired the proper method of seeing and thinking, the student will have little trouble in picking up much more information than can possibly be given to him in any superficial course of cramming. Teach him to see, to think and to speak clearly, and all will be well.

Professor W. C. Peckham, of Adelphi College, urged that the attention of the young pupil should be directed to the phenomena of nature about him; to the

changes he may observe in the seasons, the days and the nights; the changes in the weather, the dews, the fogs and rain, hail, snow, the rainbow and the lightning flash. All these should be the occasion of instruction. He should be taught the laws of the action of any machines in the house, on the farm or in the mills of a neighborhood. In the later years of the grammar school and in the high school, place should be found for experimental physics in the illustration of laws. The demonstration of laws is beyond the power of the pupil of this age. This belongs to the well-equipped student of the University. Measurements adapted to the stage of advancement of the pupil may be made in all parts of such a course, though much that passes for physical-laboratory work is only physical arithmetic or geometry, and should be done in the time devoted to mathematics.

If such a course should be carried out, the student would early begin to observe, reflect upon and endeavor to explain what he sees before him in daily life, to be intelligent with reference to the course and constancy of nature. Everything will not then to him be shrouded in mystery and weighty with omen. Such knowledge acquired in the grammar and high-school years will constitute the surest and best foundation for the course in modern physics, the science of the transformation of energy as taught in the college.

The other speakers of the afternoon were Principal William M. Bennett, of Canandaigua; Principal Henry Pease, of Medina; Professor Irving P. Bishop, of Buffalo; Professor H. J. Schmitz, of Genesee; Professor Morris Loeb, of New York University; Professor G. C. Caldwell, of Cornell; Professor H. C. Coon, of Alfred, and Professor Henry L. Griffis, of New Paltz.

It was evident that on one point the Association is practically unanimous: that of all the sciences which the colleges might

require for admission, physics is the one that the preparatory schools are best adapted to handle, and that the student is most in need of. The discussion showed clearly also that, in order to do the work in physics as it should be done, the secondary schools need to devote more time and thought to this work, and in some cases, perhaps, less time and thought to work in the other sciences. The laboratory method is indispensable. Several speakers were in favor of leaving all the work in chemistry to be done in college.

After the discussion, the following resolution, offered by Dr. Hallock, was unanimously adopted: "*Resolved*, That this Association urges Congress to take such action as will bring into use, by the government and by the people, the metric system of weights and measures at as early a date as is practicable."

FRANKLIN W. BARROWS,
Secretary.

BUFFALO, N. Y.
(*To be continued.*)

CURRENT NOTES ON METEOROLOGY.

BLUE HILL CLOUD OBSERVATIONS.

CLAYTON'S 'Discussion of the Cloud Observations' made at Blue Hill Observatory (*Annals Astron. Obs'y Harv. Coll.*, Vol. XXX., Pt. IV.) is a product of which American science has abundant reason to be proud. It represents the results of years of the most careful work at Blue Hill Observatory on the heights, velocities, movements, formation and classification of clouds, and is, as it stands, the most complete publication on the subject of clouds yet issued in any country. That the observers at Blue Hill were doing some excellent cloud work has been known for some years, and short articles by the meteorologist of the station (Mr. H. H. Clayton), which have appeared from time to time in scientific journals in Europe and in this country, have given evidence that some interesting results were